European Inland Fisheries Advisory Commission

EIFAC Occasional Paper No. 45

ICES Advisory Committee on Fisheries Management

ICES CM 2009/ACOM:15

Ref. ACOM, DFC

ISSN 0258-6096

Report of the 2009 session of the Joint EIFAC/ICES Working Group on Eels

Göteborg, Sweden,7–12 September 2009

Report of the 2009 Session of the Joint EIFAC/ICES Working Group on Eels

Göteborg, Sweden, 7–12 September 2009

European Inland Fisheries Advisory Commission
Food and Agriculture Organization of the United Nations
Rome

International Council for the Exploration of the Sea
Copenhagen

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2010

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
Copenhagen, 2010

FAO E-ISBN 978-92-5-106499-3

Preparation of this document

This publication is the Report of the 2009 session of the Joint European Inland Fisheries Advisory Commission (EIFAC) and International Council for the Exploration of the Sea (ICES) Working Group on Eels which was held in Göteborg, Sweden, from 7 to 12 September 2009.

Contact addresses:

European Inland Fisheries Advisory Commission
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy
Telephone (+39) 06 5705 4376
Telefax (+39) 06 5705 3360
www.fao.org publications-sales@fao.org

International Council for the Exploration of the Sea
H.C. Andersens Boulevard 44–46
DK-1553 Copenhagen V, Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk info@ices.dk

Abstract

From the information available indications are that the stock is at an historical minimum, continues to decline and is outside safe biological limits. Anthropogenic mortality is thought to be high on both juvenile (glass eel) and older eel (yellow and silver eel). Recruitment to the stock is at a historically low level and continues to decline with no obvious sign of recovery. Current levels of anthropogenic mortality are not sustainable and there is an urgent need that these should be reduced to as close to zero as possible until a recovery of the stock is achieved.

All glass eel recruitment series demonstrate a clear decline since the early 1980s. Between 2008 and 2009 (2009 data still incomplete) the decrease has been sharp: an in-year drop of around 50–60% for glass eel landings. For the different areas (Baltic, continental North Sea, continental Atlantic, British Isles, and Mediterranean), levels have dropped to between 1 and 9% of the 1970s levels. The continental North Sea yellow eel recruitment series have been declining continuously since the 1950s. The Baltic series have dropped to less than 10% of their initial values between the 1950s and 1970s and remain at a low level.

For the last 4 years, the series based on glass eel average between 4% (continental North Sea) and 12% (continental Atlantic) of their mean 1979–1994 value and <1% to 9% of pre 1979 levels respectively. A similar 4 year average calculated for scientific series and series based on trap for glass eels have dropped to 4–5% of their mean 1979–1994 value whereas on the other hand series based on total catch and cpue remain at a higher level (11 and 15% respectively). The series for yellow eel are currently at 17% (North Sea) to 91% (Baltic) of their mean 1979–1994 value and 5% to 7% of the pre 1960s levels respectively.

Total landings data have been found to be unreliable and it is hoped that the implementation of the EU DCR might improve this situation. There was a great heterogeneity among the landings data with incomplete and inconsistent reporting by countries. It was, therefore, considered inappropriate to analyse trends. Changes in management practices were found to have also changed the reporting of non-commercial and recreational fisheries.

New data on habitat and historical and current silver eel production and escapement data should become available through the Eel Management Plan process. It is essential that collection of these data are coordinated and of good quality as they will likely form the basis for international stock assessment and post-evaluation of the implementation of the Regulation. The formation of an international database for recruitment and landings time-series was discussed and tested by the WG. It is hoped to further develop this to include the new data required for stock assessment. Management of such a database is an important issue.

ICES have tasked WGs to make an evaluation of the issues relating to the quality of assessment data, and to this end the WG reviewed a subset of Country Reports according to evaluation criteria. Basic data of Catch (C) and effort (f) and the main fishery indicators: C total (landings/ fishing mortality), f total, and abundance index (generally cpue) for eel are very often poorly evaluated, if not missing. Moreover, they are not clearly reported by biological stages (glass eel, yellow, silver), by fishing categories or by appropriate management unit. The indicators from recreational fishermen are generally missing and no estimation is made in the absence of data. Nothing is reported about illegal fishing. The fishery indicators for eel are not associated

with a "quality value" and their representative value and accuracy is globally unknown.

The EU Regulation requires Member States to report every third year commencing in 2012 on the effectiveness and outcome of management measures implemented. It is likely that these plans will lead to an improvement in survival and silver eel escapement. These improvements, however, are not likely to lead to a substantial change in the status of the stock by 2012, because of the short time interval, the delayed effects of protection of the younger stages and indirect effects cascading through slowly. Noting the many uncertainties concerned and the low precision in existing monitoring programmes, effects of protection will be difficult to detect in 2012.

A framework for post-evaluation of management measures, both at the scale of individual Eel Management Units, and on the international scale, has been worked out in this report, but little practical experience is currently available, and the development of the tools required is not planned. It is of utmost importance that these developments are planned and initiated in time to be available for the 2012 post-evaluation. Additionally, the collection of data (under the DCR and in relation to national EMPs) should be tuned to their usage in post-evaluations. This planning process requires the involvement and commitment from relevant national and international agencies (governments and research agencies). The research required (e.g. development of generic tools for local and international post-evaluation) goes beyond the capacity of WGEEL and will require a dedicated research project. Noting the urgent need to plan and coordinate the data collection and tool development for the 2012 post-evaluation, it is recommended that international coordination and planning be established immediately for the organization and facilitation of eel management, for the development of assessment tools, for the collection of data, and for the coordination and standardization of the post-evaluations in 2012.

Stocking eel is listed as one management option in the Regulation, and a measure in most of the Eel Management Plans (EMPs) drawn up to meet the regulation, with a view to using stocking to supplement weakened stocks, or even replace lost ones, and as an aid to meeting the long-term silver eel escapement targets. Comparative experiments reviewed indicate that wild eel generally have higher survival rates than stocked ones in open systems. Current data indicate that glass eel availability is so low as to make this aspiration impossible on a stock-wide scale. This forces the conclusion that best use must be made of the remaining glass eel available for stocking. Stock should preferentially go to areas likely to maximize high quality silver eel escapement. To this end, all stocking programmes should have the facility for post-evaluation built in at the outset.

The European Eel Quality Database (EEQD) has been updated with data on contaminants, pathogens and fat levels in eel, enabling the compilation of a comprehensive overview of the distribution area. Results demonstrate highly variable data within river basin districts, according to local anthropogenic pollution, linked with land use. Persistently elevated contamination levels, above human consumption standards, are seen in many European countries. Estimation of effective spawner biomass requires quantification of the adverse effects of contaminants, pathogens and low fat levels on the capacity of eel to migrate and spawn successfully. In the absence of quantitative studies, comparisons with threshold values of toxic compounds in other fish species indicated that the body burden of compounds such as PCBs, DDT and dieldrin in eels from many parts of Europe are so high that effects at the population level are likely to occur.

Some general advances in the field of eel science were discussed in the Report. Most elements of the natural reproduction of *A. anguilla* and *A. rostrata,* including their migration routes and spawning grounds, still remain unknown, although investigations into their artificial reproduction are yielding some useful information.

FAO European Inland Fisheries Advisory Commission; International Council for the Exploration of the Sea.

Report of the 2009 session of the Joint EIFAC/ICES Working Group on Eels. Göteborg, Sweden, from 7 to 12 September 2009. EIFAC Occasional Paper. No. 45. ICES CM 2009/ACOM:15. Rome, FAO/Copenhagen, ICES. 2010. 540p. (Online).

Executive summary

This Report summarizes the presentations, discussions and recommendations of the 2009 session of the Joint EIFAC/ICES Working Group on Eels which took place in Göteborg, Sweden, hosted by the Swedish Board of Fisheries, from 7 to 12 September 2009.

In this section, the main outcomes from the report are summarized, a forward focus is proposed in the light of the EU Regulation for the Recovery of the Eel Stock and the main recommendations are presented.

It is clear from this Report that recruitment is still low and in many time-series it continues to fall, the stock is in decline and urgent protection measures are required. Significant pressures have been placed on the scientific and technical system to support the delivery of Eel Management Plans by December 2008. This challenging situation has continued though 2009 with the evaluations of submitted plans taking place. The evaluation of eel management plans has been carried out by the ICES Secretariat as a technical evaluation and review service. Eel experts from the ICES communities, especially the joint EIFAC/ICES Working Group on Eel, have been involved on an *ad hoc* technical/expert consultant basis.

Summary of this report

From the information available indications are that the stock is at an historical minimum, continues to decline and is outside safe biological limits. Anthropogenic mortality is thought to be high on both juvenile (glass eel) and older eel (yellow and silver eel). Recruitment to the stock is at an historically low level and continues to decline with no obvious sign of recovery. Current levels of anthropogenic mortality are not sustainable and there is an urgent need that these should be reduced to as close to zero as possible until a recovery of the stock is achieved.

All glass eel recruitment series demonstrate a clear decline since the early 1980s. Between 2008 and 2009 (2009 data still incomplete) the decrease has been sharp: an in-year drop of around 50–60% for glass eel landings. For the different areas (Baltic, continental North Sea, continental Atlantic, British Isles, and Mediterranean), levels have dropped to between 1 and 9% of the 1970s levels. The continental North Sea yellow eel recruitment series have been declining continuously since the 1950s. The Baltic series have dropped to less than 10% of their initial values between the 1950s and 1970s and remain at a low level.

For the last 4 years, the series based on glass eel average between 4% (continental North Sea) and 12% (continental Atlantic) of their mean 1979–1994 value and <1% to 9% of pre 1979 levels respectively. A similar 4 year average calculated for scientific series and series based on trap for glass eels have dropped to 4–5% of their mean 1979–1994 value whereas on the other hand series based on total catch and cpue remain at a higher level (11 and 15% respectively). The series for yellow eel are currently at 17% (North Sea) to 91% (Baltic) of their mean 1979–1994 value and 5% to 7% of the pre 1960s levels respectively.

Total landings data have been found to be unreliable and it is hoped that the implementation of the EU DCR might improve this situation. There was a great heterogeneity among the landings data with incomplete and inconsistent reporting by countries. It was, therefore, considered inappropriate to analyse trends. Changes in management practices were found to have also changed the reporting of non-commercial and recreational fisheries.

New data on habitat and historical and current silver eel production and escapement data should become available through the Eel Management Plan process. It is essential that collection of these data are coordinated and of good quality as they will likely form the basis for international stock assessment and post-evaluation of the implementation of the Regulation. The formation of an international database for recruitment and landings time-series was discussed and tested by the WG. It is hoped to further develop this to include the new data required for stock assessment. Management of such a database is an important issue.

ICES have tasked WGs to make an evaluation of the issues relating to the quality of assessment data, and to this end the WG reviewed a subset of Country Reports according to evaluation criteria. Basic data of Catch (C) and effort (f) and the main fishery indicators: C total (landings/ fishing mortality), f total, and abundance index (generally cpue) for eel are very often poorly evaluated, if not missing. Moreover, they are not clearly reported by biological stages (glass eel, yellow, silver), by fishing categories or by appropriate management unit. The indicators from recreational fishermen are generally missing and no estimation is made in the absence of data. Nothing is reported about illegal fishing. The fishery indicators for eel are not associated with a "quality value" and their representative value and accuracy is globally unknown.

The EU Regulation requires Member States to report every third year commencing in 2012 on the effectiveness and outcome of management measures implemented. It is likely that these plans will lead to an improvement in survival and silver eel escapement. These improvements, however, are not likely to lead to a substantial change in the status of the stock by 2012, because of the short time interval, the delayed effects of protection of the younger stages and indirect effects cascading through slowly. Noting the many uncertainties concerned and the low precision in existing monitoring programmes, effects of protection will be difficult to detect in 2012.

A framework for post-evaluation of management measures, both at the scale of individual Eel Management Units, and on the international scale, has been worked out in this Report, but little practical experience is currently available, and the development of the tools required is not planned. It is of utmost importance that these developments are planned and initiated in time to be available for the 2012 post-evaluation. Additionally, the collection of data (under the DCR and in relation to national EMPs) should be tuned to their usage in post-evaluations. This planning process requires the involvement and commitment from relevant national and international agencies (governments and research agencies). The research required (e.g. development of generic tools for local and international post-evaluation) goes beyond the capacity of WGEEL and will require a dedicated research project. Noting the urgent need to plan and coordinate the data collection and tool development for the 2012 post-evaluation, it is recommended that international coordination and planning be established immediately for the organization and facilitation of eel management, for the development of assessment tools, for the collection of data, and for the coordination and standardization of the post-evaluations in 2012.

Stocking eel is listed as one management option in the Regulation, and a measure in most of the Eel Management Plans (EMPs) drawn up to meet the regulation, with a view to using stocking to supplement weakened stocks, or even replace lost ones, and as an aid to meeting the long-term silver eel escapement targets. Comparative experiments reviewed indicate that wild eel generally have higher survival rates than stocked ones in open systems. Current data indicate that glass eel availability is so low as to make this aspiration impossible on a stock-wide scale. This forces the conclusion that best use must be made of the remaining glass eel available for stocking. Stock should preferentially go to areas likely to maximize high quality silver eel escapement. To this end, all stocking programmes should have the facility for post-evaluation built in at the outset.

The European Eel Quality Database (EEQD) has been updated with data on contaminants, pathogens and fat levels in eel, enabling the compilation of a comprehensive overview of the distribution area. Results demonstrate highly variable data within river basin districts, according to local anthropogenic pollution, linked with land use. Persistently elevated contamination levels, above human consumption standards, are seen in many European countries.

Estimation of effective spawner biomass requires quantification of the adverse effects of contaminants, pathogens and low fat levels on the capacity of eel to migrate and spawn successfully. In the absence of quantitative studies, comparisons with threshold values of toxic compounds in other fish species indicated that the body burden of compounds such as PCBs, DDT and dieldrin in eels from many parts of Europe are so high that effects at the population level are likely to occur.

Some general advances in the field of eel science were discussed in the Report. Most elements of the natural reproduction of *A. anguilla* and *A. rostrata*, including their migration routes and spawning grounds, still remain unknown, although investigations into their artificial reproduction are yielding some useful information.

Forward focus

This Report is a further step in an ongoing process of documenting eel stock status and fisheries and developing a methodology for giving scientific advice on management to affect a recovery in the European eel stock. A European Regulation for recovery of the stock was adopted in 2007 by the EU Council of Ministers. Further scientific advice will be required for the implementation, monitoring and post-evaluation of the Regulation, at both national and international levels. The implementation of the management plans formulated under the Regulation should improve and extend the information on stock and fisheries. Improved reliability and better spatial coverage will, however, also generate a breakpoint in several currently available time-series; correction procedures will need to be considered. In 2012, EU Member States will report on protective measures implemented in their territories, and their effects on the stock, a process for which assessment methodology is currently limited. For effective evaluation of change in stock at the International level, the working group will need access to data gathered within the framework of national/regional management plans. Gaps have been identified where these data may fall short of that required. There will be a need for an international database compiled from regional components; and post-evaluation procedures for measuring the impact of corrective actions on the stock.

The EU Eel Regulation and associated eel management plans, CITES and the EU DCR for Eel are likely to force radical change in management of eel, and the Working Group is therefore entering into a dynamic period in which it is difficult to be categorical on its future focus. For efficient use of both working group time and the experience of the participants, it is recommended that a series of workshops and/or study groups are formed to make progress on specific issues. The future focus of the Working Group might concentrate on:

- the assessment of trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;
- the development of methods to post-evaluate effects of implementation of the Regulation on eel at the stock-wide level (in conjunction with the SGIPEE);
- the development of methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures (in conjunction with SGAESAW);
- the establishment of international databases on eel stock, fisheries, other anthropogenic impacts and habitat and eel quality related data;
- development of methods to account for data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, in stock assessment methods;
- reviewing and developing approaches to quantifying the effects of eel quality on stock dynamics and integrating these in stock assessment methods;
- responding to specific requests in support of the eel stock recovery Regulation, as necessary; and
- reporting on improvements to the scientific basis for advice on the management of European and American eel.

Forward focus strategy

The WG proposes that a study group be set up on the establishment of an international post-evaluation for eel (SGIPEE). This group would meet during 2010 and 2011 to progress the concept discussions reported by WGEEL 2008 and 2009 in Chapter 3 of its reports and to set up a structure and methodology for the stock assessment and post-evaluation anticipated in 2012. The SG would report to WGEEL for deliberation and inclusion in the annual ToR for the WG. (See Annex 5).

The WG endorses the proposal for a further study group on the development of local stock assessment methods in saline waters and suggests that this SG should also report to the annual WGEEL meetings. (See SGAESAW Report and Annex 6).

The WG endorses the need for a further Workshop on the issue of Eel Age Reading with an exchange of images in 2010 and a formal inter-calibration in early 2011. (See Annex 7).

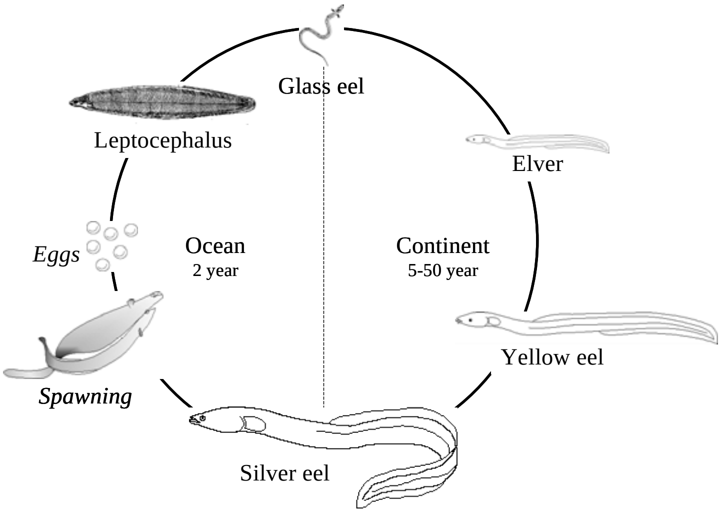
Main recommendations

- Since overall recruitment remains at an all time low since records began, the stock continues to decline and stock recovery will be a long-term process for biological reasons, all negative anthropogenic factors impacting on the stock and affecting the production/escapement of silver eels should be reduced to as low as possible, until long-term stock recovery is achieved.
- The 2001 meeting of WGEEL (ICES 2002) recommended the formation of an international commission for the management of the European eel stock. Such a body could organize the monitoring and research on eel stocks and fisheries, serve as a clearing house for regular exchange of information regarding the resource status and facilitate/orchestrate management and research.

  Noting the urgent need to plan and coordinate the data collection and tool development for the 2012 post-evaluation, this recommendation is reiterated. Such an internationally coordinating and planning group could either parallel the North Atlantic Salmon Conservation Organization, NASCO, or fit into the scheme of Regional Advisory Committees RACs in the EU, albeit focused on a single most wide-spread stock (instead of a single region with many species); an Eel Advisory Committee.

Glossary

Eels are quite unlike other fish. Consequently, eel fisheries and eel biology come with a specialised jargon. This section provides a quick introduction for outside readers. It is by no means intended to be exhaustive.



The life cycle of the European eel. The names of the major life stages are indicated. Spawning and eggs have never been observed in the wild.

Glass eel	Young, unpigmented eel, recruiting from the sea into continental waters
Elver	Young eel, in its 1st year following recruitment from the ocean. The elver stage is sometimes considered to exclude the glass eel stage, but not by everyone. Thus, it is a confusing term.
Bootlace, fingerling	Intermediate sized eels, approx. 10–25 cm in length. These terms are most often used in relation to stocking. The exact size of the eels may vary considerably. Thus, it is a confusing term.
Yellow eel (Brown eel)	Life stage resident in continental waters. Often defined as a sedentary phase, but migration within and between rivers, and to and from coastal waters occurs. This phase encompasses the elver and bootlace stages.
Silver eel	Migratory phase following the yellow eel phase. Eel characterized by darkened back, silvery belly with a clearly contrasting black lateral line, enlarged eyes. Downstream migration towards the sea, and subsequently westwards. This phase mainly occurs in the second half of calendar years, though some are observed throughout winter and following spring.
Eel River Basin or Eel Management Unit	“Member States shall identify and define the individual river basins lying within their national territory that constitute natural habitats for the European eel (eel river basins) which may include maritime waters. If appropriate justification is provided, a Member State may designate the whole of its national territory or an existing regional administrative unit as one eel river basin. In defining eel river basins, Member States shall have the maximum possible regard for the administrative arrangements referred to in Article 3 of Directive 2000/60/EC [i.e. River Basin Districts of the Water Framework Directive].” EC No. 1100/2007

River Basin District	The area of land and sea, made up of one or more neighbouring river basins together with their associated surface and groundwaters, transitional and coastal waters, which is identified under Article 3(1) of the Water Framework Directive as the main unit for management of river basins. Term used in relation to the EU Water Framework Directive.
Stocking	Stocking is the practice of adding fish [eels] to a waterbody from another source, to supplement existing populations or to create a population where none exists.

Perdimus anguillam dum manibus stringimus illam.

WGEEL, Göteborg 2009; (Detail from the fountain "Poseidon" by Carl Milles 1931; Göteborg).

Contents

1 Introduction

1.1 The 2009 WGEEL

At the 96th Statutory Meeting of ICES (2008) and the 25th meeting of EIFAC (2008) it was decided that:

2008/2/ACOM15: The **Joint EIFAC/ICES Working Group on Eels** [WGEEL] (Chair: Russell Poole, Ireland), will meet in Gothenburg, Sweden, 7–12 September 2009, to:

a) assess the trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;

b) Evaluate the EU eel management plan;

c) develop methods to post-evaluate effects of management plans at the stock-wide level;

d) develop methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures;

e) establish international databases on eel stock, fisheries and other anthropogenic impacts, as well as habitat and eel quality related data, and the review and development of recommendations on inclusion of data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, on stock assessment methods;

f) review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these in stock assessment methods;

g) respond to specific requests in support of the eel stock recovery Regulation, as necessary; and

h) report on improvements to the scientific basis for advice on the management of European and American eel.

WGEEL will report by 22 September 2009 for the attention of ACOM and DFC.

34 people attended the meeting, from fifteen countries (see Annex 1).

The current Terms of Reference and Report constitute a further step in an ongoing process of documenting the status of the European eel stock and fisheries and compiling management advice. As such, the current Report does not present a comprehensive overview, but should be read in conjunction with previous reports (ICES, 2000; 2002; 2003; 2004, 2005a, 2006, 2007 and 2008).

In addition to documenting the status of the stock and fisheries and compiling management advice, in previous years the Working Group also provided scientific advice in support of the establishment of a recovery plan for the stock of European Eel by the EU. In 2007, the EU published the Regulation establishing measures for the recovery of the eel stock (EC 1100/2007). This introduced new challenges for the Working Group, requiring development of new methodologies for local and regional stock assessments and evaluation of the status of the stock at the international level. Implementation of the Eel Management Plans will likely introduce discontinuities to data trends and may require a shift from fisheries-based to scientific survey-based assessments. This challenging situation has continued though 2009 with the evaluations of submitted plans taking place. The evaluation of eel management plans has been carried out by the ICES Secretariat as a technical evaluation and review service.

Eel experts from the ICES communities, especially the joint EIFAC/ICES Working Group on Eel, have been involved on an ad hoc technical/expert consultant basis.

The structure of this report does not strictly follow the order of the Terms of Reference for the meeting, because different aspects of subjects were covered under different headings, and a rearrangement of the Sections by subject was considered preferable. The meeting was organized in five subgroups using the Agenda in Annex 2. The subgroups, under the headings of "Data trends, data quality and international databases", "Stock Assessment and Post-evaluation", "Advances in Stocking", "Eel Quality" and "Advances in Eel Science" addressed the Terms of Reference as follows:

Chapter 2 presents trends in recruitment, stock, fisheries and aquaculture (ToR a). Chapter 2 also addresses new data issues and the development of an international database, in conjunction with the stock assessment subgroup and presents some data quality issues (ToR a, e).

Chapter 3 continues the line of development commenced in the 2008 report, the concept of post-evaluation and stock assessment at the international level, discusses how a post-evaluation might be structured, manages expectation for silver eel monitoring by 2012 and presents a demographic model. (ToR a, c and d).

Chapter 4 reviews new data on stocking, the relative contribution/survival of stocked compared with wild eel and makes recommendations to optimize the use of a scarce and declining resource (ToR d and h).

Chapter 5 updates the European Eel Quality Database (EEQD) and discusses the importance of the inclusion of spawner quality parameters in stock management advice (ToR e and f).

Chapter 6 reviews any significant new research findings, particularly in relation to advances in artificial reproduction and oceanic factors. Reference is made to other *Anguillid* species.

Terms of Reference a. (revision of catch statistics) is the follow-up of the analysis made in the Report of the 2004 meeting of the Working Group (ICES 2005, specifically Annex 2). Following that meeting, a Workshop was held under the umbrella of the European Data Collection Regulation (DCR), in September 2005, Sånga Säby (Stockholm, Sweden). The Workshop report presented catch statistics in greater detail than had been handled by this Working Group before. Additionally, a further improvement of the catch statistics is foreseen, when the DCR is actually implemented for the eel fisheries across Europe. It is envisaged that additional data and improved data will become available under the Eel and Data Collection Regulations. An initial review is incorporated in Chapter 2.

1.2 Workshop on Age Reading of European and American Eel (WKAREA)

The **Workshop on Age Reading of European and American Eel** [WKAREA] (Chair: Françoise Daverat (France); Co-chairs Hakan Wickström (Sweden), Russell Poole (Ireland) and John Casselman (Canada – not present at workshop)) was held from 20–24 April 2009 in Bordeaux, France to:

a) review literature and current practices on eel age reading;

b) review the methods used by participating institutes to prepare and store eel otoliths, and the processes and protocols currently used to read them (including quality assurance methods);

c) review approaches for validating eel age reading;

d) conduct an otolith exchange study between participating institutes before the workshop to compare age reading results;

e) establish a common methodology for age reading and determine the precision and bias of corresponding age reading data;

f) establish a common methodology for otolith preparation and age reading;

g) determine the precision and bias of eel age reading data derived from different readers and methods;

h) develop a manual to describe the agreed methodology; and

i) recommend, if needed, a framework to improve and to validate age reading.

Descriptions of national sampling, otolith preparation technique and age determination protocols were updated in Chapter 5 (ToR a and b). The methods used by the participating institutes were reviewed in Chapter 5 as well as the validations of eel age reading in Chapter 6 (ToR b and c). An exchange of otolith pictures from both species, based on the age estimation of 25 readers was conducted and the age reading results were discussed during the meeting (ToR d), leading to the conclusion that additional data (e.g. location, date of capture, history of stocking) are necessary to be known before reading. In Chapter 7 an inter-reader calibration was carried out based on a limited number of samples, and we recommend to conduct a reading of a significant number of otolith pictures (>100) of known and unknown age to accurately demonstrate inter-reading calibration, using the otolith manual (ToR f and g). A manual was agreed based upon plenary discussion of individual participants' current methodologies (ToR h). The exchange that is recommended to take place after the workshop should have improved age reading based on the manual (ToR i).

The Report of the Workshop is available on the ICES website:

http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=370

1.3 Study Group on Anguillid Eels in Saline Waters (SGAESAW)

The **Study Group on Anguillid Eels in Saline Waters** [SGAESAW] (Chair: David Cairns (Canada)) met on 16–18 March 2009 in Sackville, Canada, and on 3–5 September 2009, in Gothenburg, Sweden, to:

a) review and synthesize knowledge of habitat use, demographic characteristics and stock assessment methods in *anguillid* eels in saline waters compared with these features in freshwaters, and to review and evaluate available information on the relative importance of eel production from saline vs. fresh rearing areas;

b) review and synthesize knowledge of factors which influence eels to settle in saline vs. fresh rearing areas, especially in the context of changing overall recruitment levels;

c) make recommendations on the use of habitat-specific demographic characteristics in population models (e.g. SPR, biomass targets, silver eel escapement rates), and on overall conservation approaches that embrace salinity-based differences; and

d) define research and analytic approaches for anguillid eels in saline waters that will advance progress towards the ability to construct robust stock-wide management models.

Thirty-two scientists representing 12 countries attended one or both of the meetings. There were 37 presentations, covering topics in eel habitat use, demographic characteristics, densities, populations, and relative abundance in saline and freshwater. Choice of salinity zone in growth-phase eels was also treated. The SGAESAW Report (in preparation) will summarize principal findings regarding the biology, conservation, stock assessment, and applicable methods of anguillid eels in saline vs. freshwater, and will formulate recommendations for research and management.

The Report of the Study Group will be completed by the end of October 2009.

2 Data and data quality

Chapter 2 addresses the following Terms of Reference:

a/ assess the trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;

e/ establish international databases on eel stock, fisheries and other anthropogenic impacts, as well as habitat and eel quality related data, and the review and development of recommendations on inclusion of data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, on stock assessment methods;

and also links to:

c/ develop methods to post-evaluate effects of management plans at the stock-wide level;

d/ develop methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures.

Trends in recruitment, stocking, yield and aquaculture. This section collects the time-series datasets for the analysis of the status of the European eel population through the trends in recruitment, commercial landings, non-commercial and recreational catches, stocking and aquaculture production of eel.

2.1 Recruitment data

Information on recruitment is provided by a number of datasets, relative to various stages, (glass eel and elver, yellow eel), recruiting to continental habitats (Dekker, 2002). Data of recruiting glass eels and elvers, (young of the year), and yellow eels from 47 rivers in 11 countries are updated to the last season available (2008 and in some cases 2009) and provide the information necessary to examine the trends in recruitment. These data were derived from fishery-dependent sources (i.e. catch records) and fishery-independent surveys across much of the geographic range of European eel, and cover varying time intervals. Some of them date back as far as 1920 (glass eel, Loire France) and even to the beginning of 20th century (yellow eel, Göta Älv Sweden). The recruitment time-series data in European rivers are presented in Annex Tables 1 and 2.

The series have been classified according to the type of data: commercial cpue, commercial total catch, scientific estimate, trapping partial (i.e. only a part of the glass eel or yellow eel are caught) and trapping all (all glass eel and yellow ascending a particular point of the river are caught). They have also been classified according to area: Baltic, continental North Sea, continental Atlantic, British Isles, and Mediterranean. The Baltic area does not contain any pure glass eel series.

Recruitment series in glass and yellow eel demonstrate different trends before the 1960s (Figure 2.1) and therefore it is justified to separate them in the GLM analysis. There is no longer a continual series for yellow eel in the south of Europe, and no glass eel series in the North of Europe; thus, it is impossible to separate spatial and stage analyses.

Declining trends are still evident over the last two decades for all time-series. After high levels in the late 1970s, there was a rapid decrease that still continues to the present time (Figures 2.1, 2.2, 2.3 and 2.4). However, in 2009 the decrease has been sharper than ever; especially in the Northern part of the distribution area. The most recent data indicate a further drop of around 50–60% for glass eel landings between 2008 and 2009 although the 2009 are still incomplete.

For the last 4 years the series based on glass eel average between 4% (continental North Sea) and 12% (continental Atlantic) of their mean 1979–1994 value and <1% to 9% of pre 1979 levels respectively, (Annex Table 1, Figure 2.5). A similar 4 year average calculated for scientific series and series based on trap for glass eels have dropped to 4–5% of their mean 1979–1994 value whereas on the other hand series based on total catch and cpue remain at a higher level (11 and 15% respectively) (Figure 2.6).

The series for yellow eel recruitment are currently at 17% (North Sea) to 91% (Baltic) of their mean 1979–1994 value and 5% to 7% of the pre 1960's levels respectively (Figures 2.7, 2.8, Annex Table 1).

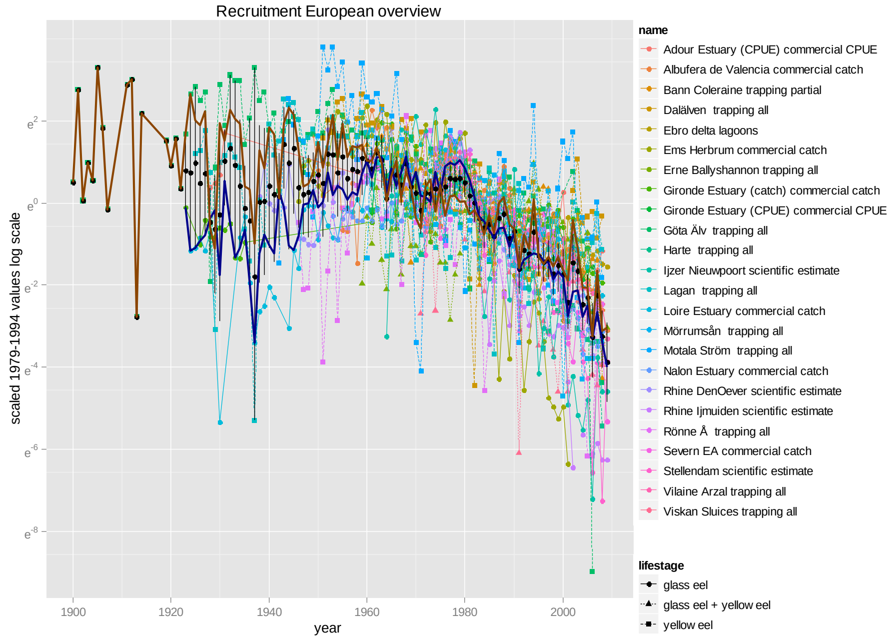


Figure 2.1: Time-series of monitoring glass eel and yellow eel recruitment in European rivers with dataseries > 35 years (24 rivers). Each series has been scaled to its 1979–1994 average. Note the <u>logarithmic scale</u> on the y-axis. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. The brown line represents the mean value for yellow eel while the blue line represents the mean value of the glass eel series. Note that for practical reasons, not all series are presented in this graph, whereas the following analysis is done on all series.

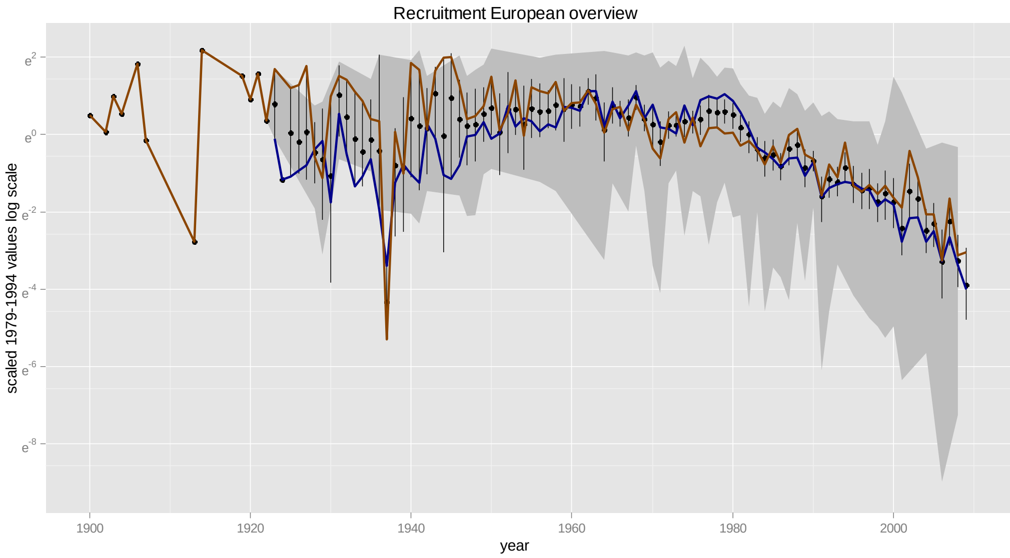


Figure 2.2: Time-series of monitoring glass eel and yellow eel recruitment in European rivers with dataseries > 35 years (24 rivers). Each series has been scaled to its 1979–1994 average. Note the <u>logarithmic scale</u> on the y-axis. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. The brown line represents the mean value for yellow eel while the blue line represents the mean value of the glass eel series. Note that individual series from Figure 2.1 were removed for clarity.

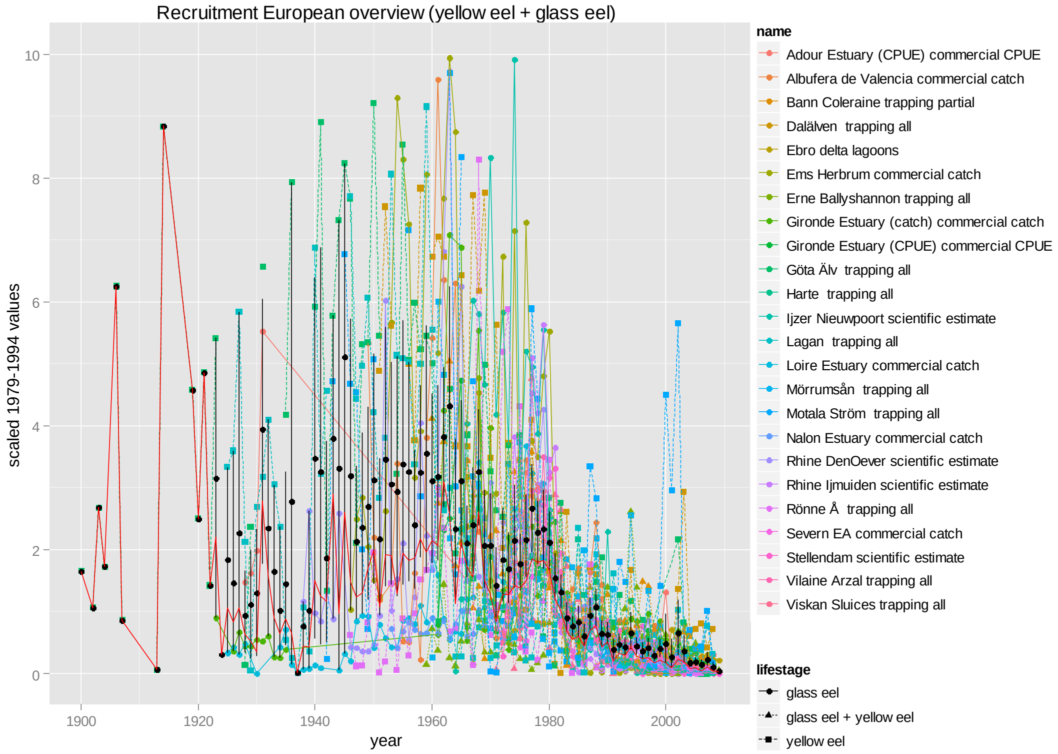


Figure 2.3: Time-series of monitoring yellow eel and glass recruitment in European rivers with dataseries > 35 years (24 rivers). Each series has been scaled to the 1979–1994 average on a <u>linear scale</u>. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. The geometric means are presented in red. The graph has been rescaled to [0.10].

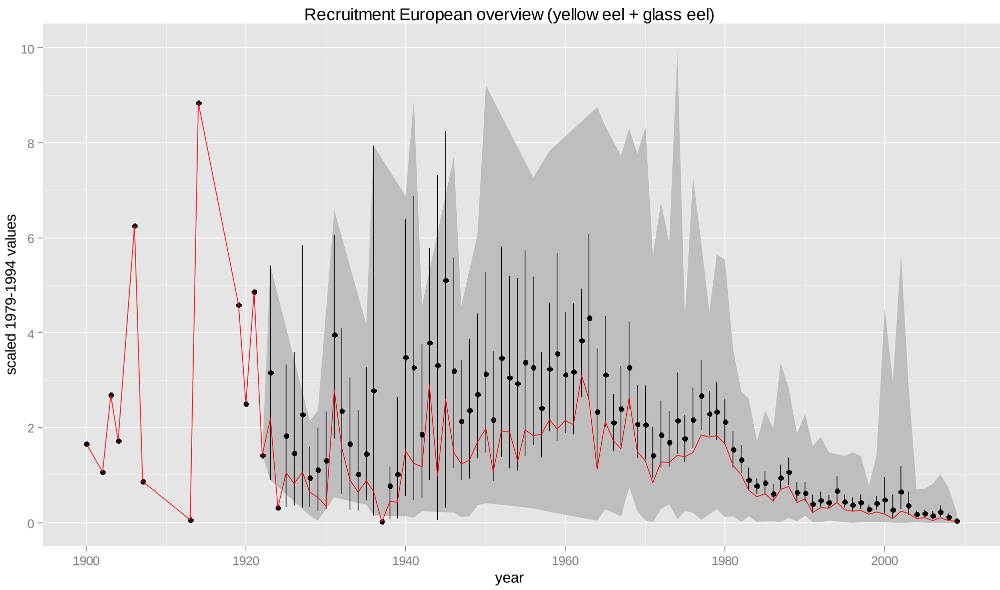


Figure 2.4: Time-series of monitoring yellow eel and glass recruitment in European rivers with dataseries > 35 years (24 rivers). Each series has been scaled to the 1979–1994 average on a <u>linear scale</u>. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. The geometric means are presented in red. The graph has been rescaled to [0.10). Note that individual series from Figure 2.3 were removed for clarity.

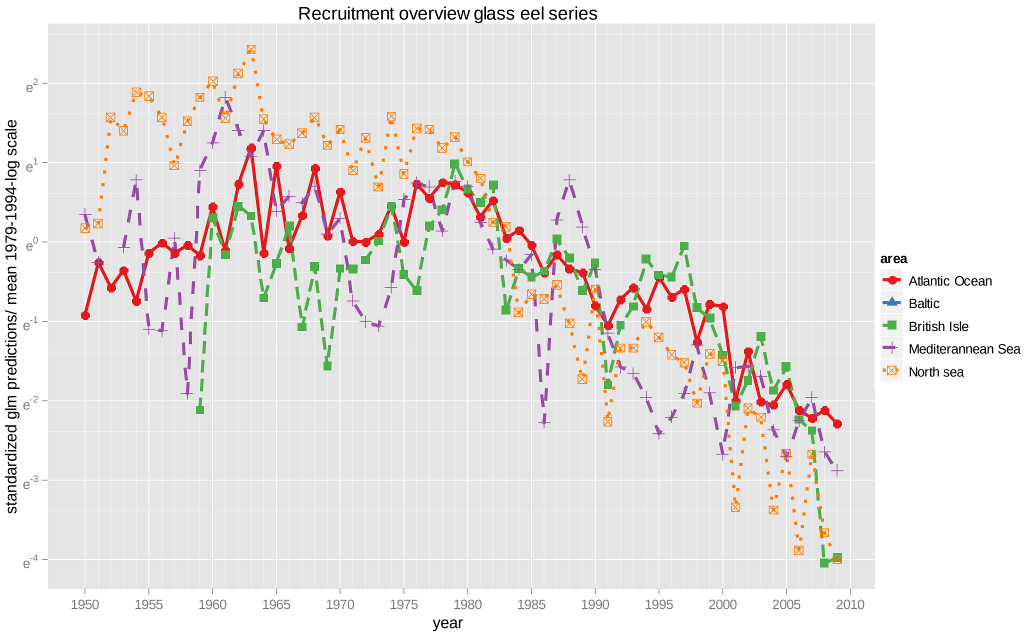


Figure 2.5: Mean of estimated (GLM) glass eel recruitment for each <u>area</u> in Europe. The GLM (recruit=area:year+site) was fitted to all glass eel series available and scaled to the 1979–1994 average. No series for glass eel are available in the Baltic area.

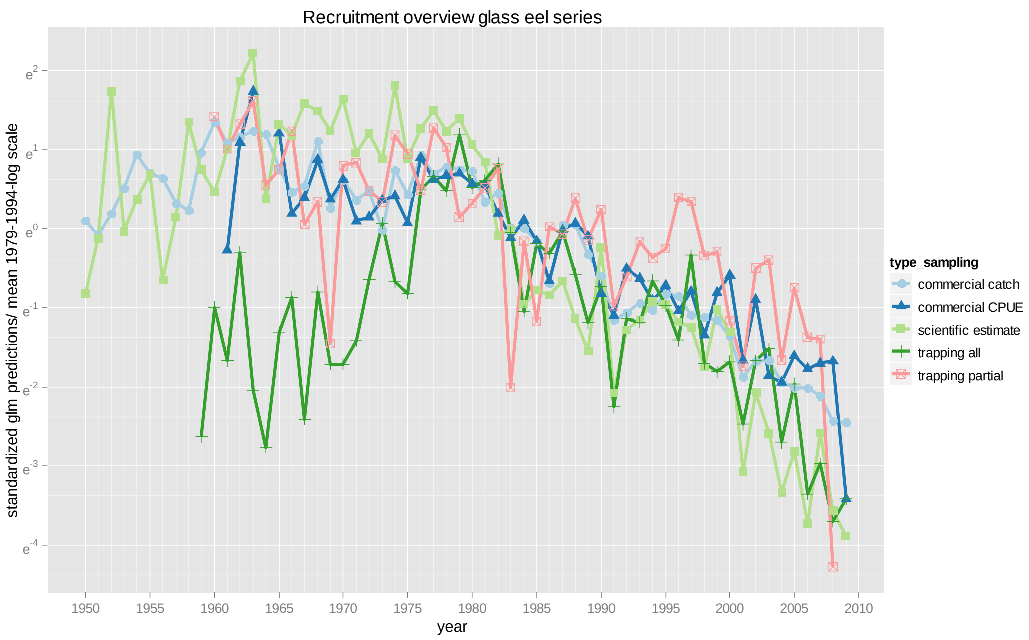


Figure 2.6: Mean of estimated (GLM) glass eel recruitment <u>per type of sampling</u> in Europe. The GLM (recruit=sampling_type:year+site) was fitted to all glass eel series available and scaled to the 1979–1994 average. No series for glass eel are available in the Baltic area.

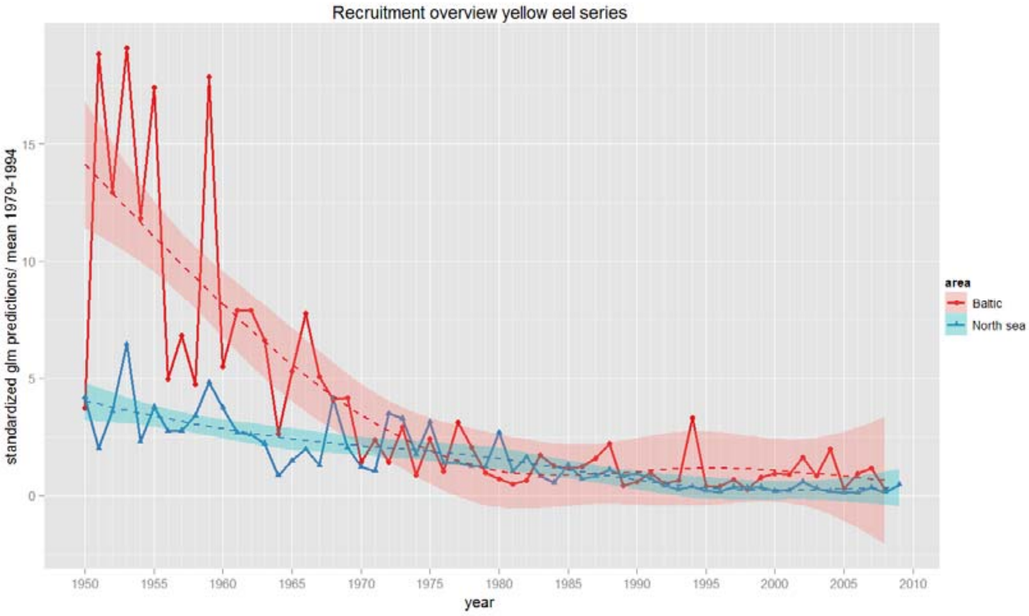


Figure 2.7: Mean of estimated (GLM) yellow eel recruitment and smoothed trends for each area in Europe. The GLM (recruit=area:year+site) was fitted to all yellow eel series available and scaled to the 1979–1994 average. Note <u>logarithmic scale</u>.

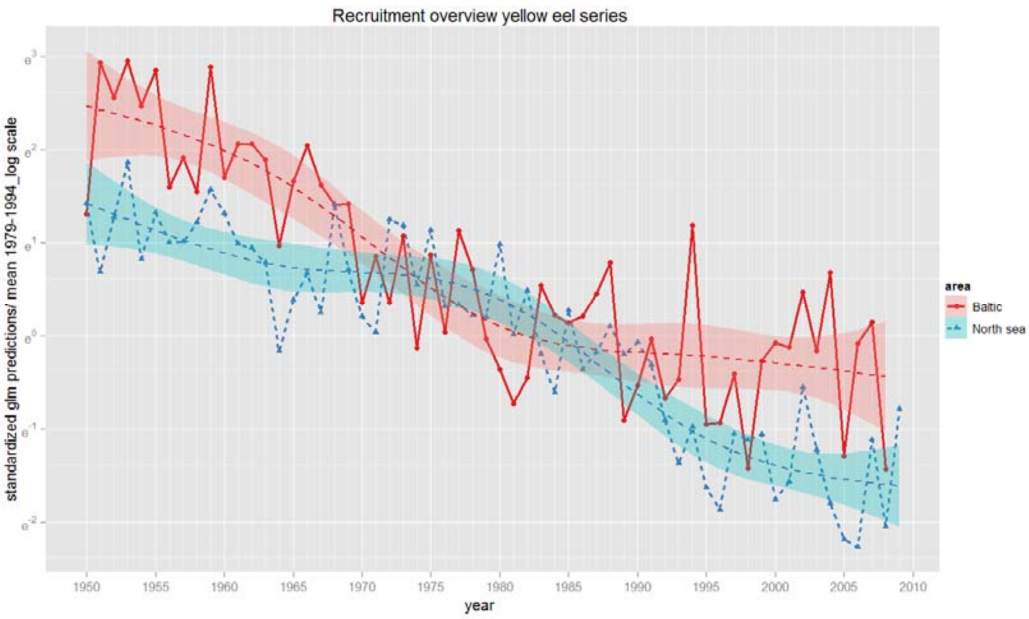


Figure 2.8: Mean of estimated (GLM) yellow eel recruitment and smoothed trends for each area in Europe. The GLM (recruit=area:year+site) was fitted to all yellow eel series available and scaled to the 1979–1994 average. Note <u>linear scale</u>.

Annex Excel Workbook contains Tables 2.1 to 2.10.

Table 2.1: GLM estimates of the level of recruitment (mean values per area).

Table 2.2: Recruitment series (real data) and accompanying information.

2.2 Data on landings

In WGEEL 2008, data on total eel landings obtained from country reports were presented, along with data on official eel landings from FAO sources. Those two datasets did not include aquaculture production. A comparison was conducted between the two datasets by comparing the mean values for corresponding periods.

Discontinuities have been noted in both the dataseries, i.e. data officially reported to FAO and the best estimates presented in the Country Reports. Implementation of the EU Eel Regulation will require Member States to implement a full catch registration system, along with the DCR Framework. This will lead to considerable improvement of the coverage of the fishery, i.e. underreporting will probably reduce markedly.

However, at the present 2009 status, dataseries from the Country Reports continue to be unreliable. A review of the catches and landing reports in the CR (section 3; Time-series for yellow and silver eel landings, section 6; Catches and landings) demonstrated a great heterogeneity in reporting landing data, with countries making reference to an official system, some of which report total landings, others report landings by Management Unit or Region, and countries without any centralized system. Furthermore, some countries have revised their dataseries, with extrapolations to the whole time-series, for the necessities of the Eel Management Plan compilation (Poland, Portugal). Others could not give total landings for all life stages and all water areas.

Annex Table 2.3 summarizes total landing series for countries contributing to the WG, while also comparing 2008 and 2009 data in Country Reports to the WG. Major discrepancies are evident for many countries. Annex Table 2.4 summarizes total landings from FAO sources (FishStat 2009).

Given the discontinuity of the landing series between countries, the incompleteness of coverage, aggregation of life stages and the different metrics, it is not appropriate to present total landings and to conduct trend analyses of European "landings" data. This makes it difficult to extrapolate from landings data to assessments of the status of the stock.

2.3 Recreational and non-commercial fisheries

Data for recreational catch, (via angling methods), and non-commercial landings for 2008–2009 are not presented by each country/region. As a result, updates are not available for the recreational and non-commercial data presented in Tables 2.1 and 2.2 from the WGEEL 2008 report. Therefore, recreational and non-commercial components are presented as a status in terms of each life stage (Table 2.5). An examination of angling licences, surveys of angler’s catch rates and communication with angler’s yield have allowed Belgium, Netherlands and Germany to estimate combined catches of yellow and silver eel at 33.6, 200 and 431 tonnes per annum respectively.

Table 2.5: Status of recreational and non-commercial eel fishing in 2008 – 'Prohibited' (by law), 'Active' (permitted under regional angling licence), 'n/a' (not applicable as a consequence of non-occurrence in the region).

	Glass eel	Yellow eel	Silver eel
Norway	Prohibited	Prohibited	Prohibited
Sweden	Prohibited	Prohibited	Prohibited
Estonia	n/a	Active	Active
Poland	n/a	Active	Active
Germany	Prohibited	Active	Active
Denmark	Prohibited	Active	Active
Netherlands	Prohibited	Active	Active
Belgium	Prohibited	Active[1]/prohib[2]	Active[1]/prohib[2]
France	Active	Active	Active
Spain*	Active	Active	Active
Portugal	Prohibited**	Active	n/a
UK	Prohibited	Active	Active
Ireland	Prohibited	Active	Active
Italy	Prohibited	Active	Active

[1] Flanders

[2] Walloon Region

*** Variations apply between autonomous regions.**

**** Except in the R. Minho**

2.4 Trends in stocking

Data on stocking were obtained from a number of countries, separated for glass eels and for young yellow eels. The size of 'young yellow eel' varies between countries. Most data available were weights which were converted to numbers, using estimates of average individual weight of the eels for a specific size stocked. These were 3.5 g for Denmark, 10 g for Poland, 33 g for the Netherlands, 20 g for (eastern) Germany, 30–60 g for Elbe RBD (up to 2005, after which actual counts are available), and 90 g (Note: 1 g eels now used in Sweden) for Sweden. An overall number of 3000 glass eels per kg was applied to data from Belgium and Northern Ireland. An overview of data available up to 2008 is compiled in (Annex Tables 2.6 and 2.7). Stocking in other EU countries, for which there are no time-series data, and which hence are not included in Annex Tables 2.6 and 2.7, are also summarized below.

Stocking Review Notes

- Lithuania: the first stocking was in 1928–1939, when 3.2 million elvers were released in the lakes. Since the 1960s, about 50 million elvers or young yellow eels have been stocked.
- Estonia: stocking on a national level.
- France: no stocking on a national level.
- Italy: historical stocking in considerable amounts in lagoons and lakes, but no national recording.
- Germany: No national database for eel stocking, but data available for some river basins. Situation will improve next year, when all data become

available in the EMP's. Stocking data for the Elbe RBD-system 1950–1980 are restricted to about 30% of the total basin area.

- Sweden: stocking on a national level.
- Spain: no stocking on a national level.
- Poland: stocking in the Vistula and Szczecin Lagoons on a national level.
- Portugal: no stocking on a national level.
- Ireland: no stocking on a national level. Upstream transport of glass eel (elver) and young yellow (bootlace) eel on the Shannon and Erne-see Country Report.
- UK: limited stocking (few kg) in England and Wales; significant stocking to Lough Neagh, Northern Ireland (215 kg in 2009).

As reported in previous WGEEL reports, the sharp drop in stocking around 1969 was as a result of glass eel transfer to Japan which resulted market deficiency and finally a high price of material assigned for re-stocking.

Stocking with glass eel has decreased strongly since the early 1990s and appears now to be at a very low level with a still decreasing trend (Figure 2.9). However, this has partly been compensated for by an increasing number of young yellow eels stocked since the late 1980s. During the 1990s stocking of young eel demonstrated an increase but dropped again in the late 1990s (Figure 2.10). During recent years, another increase in stocking young yellow eels was observed.

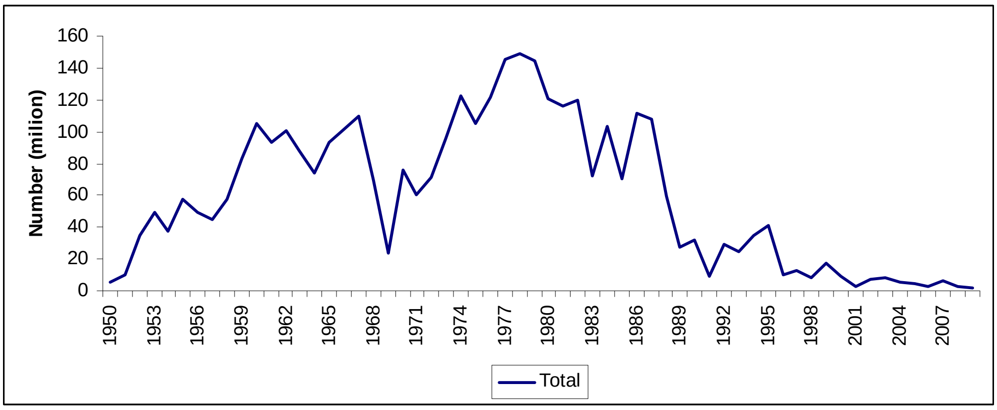


Figure 2.9: Stocking of glass eel in Europe (Germany, Lithuania, Netherlands, Denmark, Poland, Sweden, Northern Ireland, Belgium, Finland, Estonia, Latvia and Spain), in millions re-stocked.

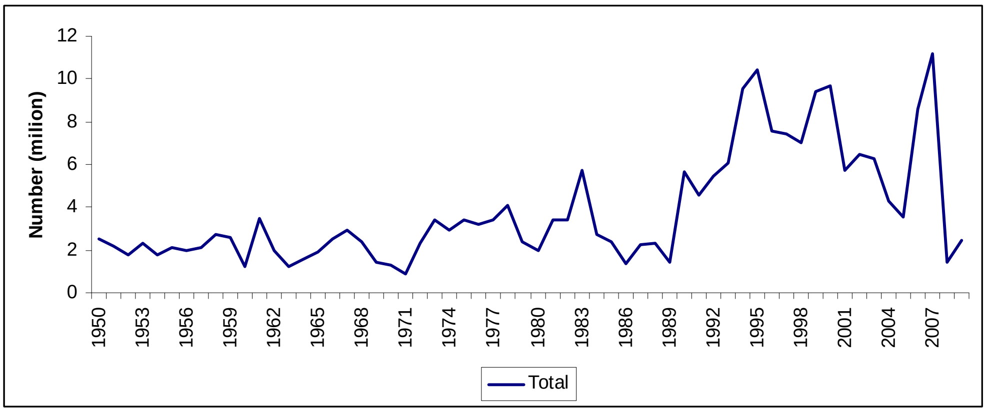


Figure 2.10: Stocking of young yellow eel in Europe (Germany, Lithuania, Netherlands, Denmark, Poland, Sweden, Belgium, Finland, Estonia, Latvia and Spain), in millions stocked.

2.5 New information available

Updated information (2008–2009) are listed and described from each country report presented for WGEEL 2009. The characteristics and format of data within each subsection are described as follows and detailed in Table 2.8.

Area

River Basin Districts (RBD), or Eel Management Units (EMUs), are listed for each country, while wetted area (ha) of respective catchments is stated.

Where data exists, separate EMP's and their respective characteristics within are represented. Distinctions between habitat types are restricted to marine, transitional and inland subcategories (rivers and lakes) where possible, but generalizations are often presented.

Production

Where available, silver eel production for 2008–2009 is represented as kg/ha.

Total silver eel production and escapement for 2008–2009 is presented in individuals or tonnes.

Continued assessment of silver eel is also listed where data are available.

Management actions

Evidence for implemented main management actions, (as of 2009), are listed, (Table 2.9). Recommendations for new legislation are not included within as they are yet to be implemented.

Stocking

Future stocking required (in kg) of glass eel needed to meet the 40% escapement target for silver eel in each country is stated (Table 2.9).

Table 2.8: Data on surface area, production and escapement per country and Eel Management Unit. Data from the Country Reports.

Country	EMU/RBD	WETTED AREA (`000 ha)			Production (kg/ha)	Potential Escapement	Escapement
		inland	transitional	coastal			
Poland	Oder	179	45.7	646.5	n.a	308 000 *	216 000 *
	Vistula	150	32.8	344.1		371 000 *	208 000 *
Sweden	All areas	32763	17843		0.067	2 870 000 * /2 600 **	1 100 000* /1 210 **
Denmark	All areas	60	n.a	n.a	n.a	300 000 * / 100** (i) 600 ** (m)	< 69** (i) 600 ** (m)
France	Rhin	7.7	0	0			
	Meuse	3.7	0	0		26 000 *	
	Artois Picardie	24.5	15.1	n.a		234 000 *	
	Seine Normandie	88	26	194		1 341 000 *	
	Bretagne	16.4	21.5	n.a		1 259 000 *	
	Loire	94.4	29.6	3250	n.a	1 231 000.*	n.a
	Garonne Dordogne	54.3	60.1	60		6 706 000 *	
	Adour	27.2	0.4	n.a		1 352 000 *	
	Rhône-Méditerranée	n.a	n.a	n.a		2 149 000.*	
	Corse	n.a	n.a	n.a		544 000 *	
England &Wales	Northumbria	6.7	2.6	70.4	4.8		36.3 ** (i)
	Humber	14.4	33.7	32.9	6.5		132.6 ** (i)
	Anglian	15.9	33.2	228.6	0.6		12.6 ** (i)
	Thames	7.4	33.5	14.5	22.6		309 ** (i)
	South East	2.4	5.5	211.2	21.3		81.9 ** (i)
	South West	7.5	22.9	304.2	20.0		176.3 ** (i)
	Severn	13.0	54.7	0.0	8.4		133.4 ** (i)
	West Wales	8.7	13.5	433.1	8.9		93.2 ** (i)
	Dee	2.2	10.9	0.0	0.03		0.068 ** (i)
	North West	11.1	27.9	150.9	13.4		200.2 ** (i)
	Solway-Tweed	23.4	39.0	191.3	9.1		118.1 ** (i)
Scotland	Scotland	186.7	n.a	n.a	n.a	84.9 ** (i)	84.9 ** (i)
N.Ireland	North Eastern	0.5	7.7	8.2	5	n.a	n.a
	Neagh Bann	40.0	0.0	40.0	9.6	400 – 600 **	360 ** (i)
	North Western	33.0	1.2	34.1	5.2	50 – 60 **	n.a
Germany	Eider	7.9	1.7	459.2	0.2 – 3.9		127 **
	Elbe	154.8	46,3	n.a	2.1		425 ** (i)
	Ems	7.8	36,1	n.a	6.5		284 ** (i)
	Maas	0.89	n.a	n.a	0.1		0 ** (i)
	Oder	51.9	28.5	n.a	1.2	n.a	100 ** (i)
	Rhein	58.9	n.a	n.a	2.9		173 ** (i)
	Schlei/Trave	23.0	0	310.8	0.9 – 2.9		358 **
	Warnow/Peene	34.8	0	310	0.6 – 2.6		822 **
	Weser	20.1	34.6	n.a	4.8		261 ** (i)
Portugal	Minho&Lima						
	Cavado,Ave&Leca						
	Douro						
	Vouga,Mondego,Lis	n.a	n.a	n.a	n.a	n.a	n.a
	Tejo						
	Sado&Mira						
	Guadiana						
	Algavere streams						

Table 2.8. cont: Data on surface area, production and escapement per country and Eel Management Unit. Data from the Country Reports.

Ireland	Eastern South-Eastern Shannon South-Western Western North-Western	7.0 4.2 45.3 10.7 49.9 36.7	2.3 9 25 16.6 13.3 13.1	35.9 102.4 122 357.6 457.4 223	1.3 – 2.7 for inland area	14 ** 10 ** 95 ** 17 ** 51 ** 38 **	7 ** 9 ** 18 ** 17 ** 51 ** 38 **
Netherlands	All areas	321.1	358.8		0.32 – 7.19	n.a	n.a
Belgium	Scheldt Meuse	n.a	n.a	n.a	n.a	n.a	n.a
Spain	Galicia Asturias Cantabria Basque Country Navarra Cataluña Ebro Valencia Castilla La Mancha Murcia Isla Baleares Andalucía	n.a	n.a	n.a	n.a	n.a	n.a
Estonia	East-Estonian West-Estonian	200	n.a	n.a 1500	n.a	n.a	n.a

(*) escapement (indiv.)

(**) escapement (tonne)

(i) escapement from inland waters

(m) escapement from marine waters

The data for Germany refer just to the areas included in the respective EMP's. For some of the RBD's/EMU's, coastal waters are hence not included here.

Table 2.9: Main actions proposed in the national EMP`s (data from country reports).

COUNTRY	STOCKING	ANTHROPOGENIC MORTALITY		
	Amount of glass eel/year	Commercial fishery	Recreational fishery	Hydropower/ pumping stations
POLAND	14 000 000 individuals	- 25 %		- ~30 %
SWEDEN	2 500 000 individuals	- 80 %		- 50 %
DENMARK	3–4 tons (inland) 33 tons (marine)	- 50 %	YES	YES
FRANCE	3.82 tons Some data n.a	n.a	n.a	n.a
ENGLANDand WALES	Not proposed	YES	YES	YES
SCOTLAND	Not proposed	Licenced control	Licenced control	n.a
N.IRELAND	12 000 000 individuals	n.a	n.a	n.a
GERMANY	increase present stocking	YES	YES	YES
PORTUGAL	n.a	YES	-100%	YES
IRELAND	n.a	-100%	Catch and release	YES
NETHERLANDS	n.a	YES	YES	YES
BELGIUM	Yes	No	Yes Flanders No Walloon Reg.	YES
SPAIN	35% of their own catches in Valencia, 5% in Catalonia; n.a other regions	n.a	n.a	YES
ESTONIA	4 000 000	YES	n.a	n.a
ITALY	n.a	n.a	n.a	n.a
NORWAY	0	-100 %	- 100 %	n.a

2.6 Development of an international database

The increase in the number and volume of data available, and the necessity to provide formatted output for analyses, has led the Working Group to discuss the structure and the scope of a database.

In the short term, a database handling the data already used by the Working Group should be built, to which a template including the recruitment data from past years has been proposed for this year. The database is simply a more efficient way of handling data currently stored in excel files and should be used only for the Working Group purpose, with the objective to provide year-to-year reports. Any processing of data would require the authorization of the data owner. The database should be structured with referential tables allowing specification of the type of location (National, EMU, river basin within an EMU), geographical units (countries, EMU), life stage, type of data (cpue, landings, recruitment series), and bibliographical references. The data would be located within three tables, one for samples, one for annual data, and one for geographical descriptions, (land and water surface). The database should be used to build consistent time-series of landings and effort, that would allow the working group an insight into past time escapement.

In the long term, data describing individual samples characteristics or detailed catches along with their spatial characteristics would be very useful for post-evaluation purposes. There are several technical issues regarding the way in which the level of detail, the spatial precision, relation to the river network, temporal precision, ownership, and the way the member state would report, could be addressed in a dedicated workshop.

2.7 Data quality issues

This sub-chapter outlines the beginnings of a process of data quality evaluation and improvement in the framework of the WGEEL and ICES. As highlighted elsewhere in this report, historically there has been a wide range of data collection methods and reporting. It is clear that the introduction of the EU Eel Regulation, the DCR and the WFD should improve this, although many dataseries will be vulnerable to inconsistencies or discontinuities as these Regulations are implemented.

2.7.1 Introduction

ICES has instructed all assessment WGs to compile a list of the data issues that could affect the quality of the assessments, and communicate these issues to data collection groups, i.e. Regional Coordination Meetings (RCM) for Data Collection Framework (DCF), and the Planning Group on Commercial Catches, Discards and Biological Sampling (PGCCDBS). This communication will be first through provision of discrete sections in the WGEEL 2009 report (and future reports), including recommendations for improving data quality, and second (if required), representation at RCM 2009 and/or PGCCDBS 2010 meetings.

The aim of the WG was, therefore, to evaluate the quality of the assessment data reported by countries and used by the WGEEL in assessment of the status of the stock. As an aid to all assessment WGs, ICES provided a table template, "Stock Data Problems Relevant to Data Collection", with columns for the ‘stock’, ‘data problem’, ‘recommended solution’ and ‘who should solve the problem’. However, assessment of the European eel stock is a complex process, requiring some combination of various data elements associated with eel stage (recruitment, production and escapement), each of which are more or less relevant and assessed between countries. Therefore, in order to begin this process of data quality evaluation for eel assessment, the WG developed a series of Data Quality Evaluation Criteria (DQEC), and constructed an associated table which could be used as a checklist. The following text explains the structure of this DQEC.

The development of the evaluation criteria follows a logic of evaluation based on several keywords:

- scale of investigation;
- basic data and indicators of catch (C), effort (f) and the abundance index as catch per unit of effort (cpue);
- Information required and conditions of quality evaluation;
- representativeness + accuracy.

The consideration of representativeness and accuracy of the data informs assessment of their reliability and hence their Quality. This can be extended to provide a notation of level of confidence or value of these data. These keyword stages are further explained in the following text, referenced according to consideration of the information provided in Country Reports.

2.7.1.1 Scale of the Country Report and all reports, papers

A primary level of global approach of quality consists in checking if the data are provided in the report, and can be recorded as yes, partly or not.

At this level, there is no consideration of the quality of the data or the results themselves but it gives the first assurance that they exist and that they can potentially be used; second, their existence is the primary condition to go further to the evaluation of their quality. This level is more a statement on what is available, on the compliance between what is requested or expected and what is provided; it is the first step to apply in the evaluation of the quality of the data and results.

2.7.1.2 Scale of the basic data collected and the associated analyses

The true evaluation of the quality is made at this scale and the method proposed is based on the following logic and steps:

a) the evaluation of quality concerns is applied to basic data of C and f and to results which are the main fishery indicators: C total, f total, abundance index (generally cpue);

b) the data and results are associated to a spatial location (fishing area) and a temporal period (fishing season);

c) the data and results refers to a biological stage (glass, yellow or silver eel).

d) the data and results have to be informed, i.e. normally linked with the previous items and linked with other **information** which concerns their:

- representativeness;
- precision;
- accuracy.

The series of information gathered around the basic data and/or results involve **conditions,** which characterize the different items of information (definitions, limits, protocols). The knowledge and detail of these conditions allows an evaluation of the present status, consistency of the item and the possible future improvement of the quality of the data.

The three characteristics representativeness, precision, and accuracy of the basic data and/or results indicate their **reliability**. The reliability of the basic data and/or results represents their overall quality.

The result of the quality evaluation can be translated in «**value**» of the basic data and/or results, **level of confidence** with a **notation** like: very good, good, passable, bad, unknown. This notation, resulting of the evaluation of the quality, determines **the possible scientific use** of the basic data and/or results. This notation, with the analysis of information and conditions available, can guide developments to i**mprovement their quality**.

2.7.1.3 Evaluation of data quality used in WGEEL assessments

The WG applied this checklist in their review by considering the information provided in a subset of five Country Reports (there being insufficient time to review all reports), completing a table for each. Note that the WG assessments are based on fishery data and therefore we have limited our evaluation of quality to the fishery data, focussing therefore on Catch, Effort and cpue (abundance indices). The Country Reports also often provide data collected from scientific surveys. For the moment, we assume that these scientific surveys are designed and conducted with data quality in mind. This may not be correct in all cases, and/or the information may not be provided in the CR, but this is an issue that can be addressed in later WGs. The results were then compiled into a single table summarizing the proportion of evaluated Country Reports that provided the information for each of the criteria (table cells) (Table 2.10).

Within the five Country Reports, none of the evaluated Country Reports have full and/or complete information necessary to evaluate the quality of their data used for national or stock-wide assessments of the status of the stock. In particular, few, if any, of the Country Reports provide information, detailed or otherwise, on effort and the associated cpue. Therefore the basic data and indicators of catch, effort and cpue are very often under-evaluated, when not missing altogether. Moreover, they are not clearly reported by eel life stage (glass eel, yellow, silver), by fishermen categories and by appropriate management unit. Overall, the fishery indicators for eel are not associated with a "quality value" and their representativeness and accuracy cannot be determined from the limited information provided in Country Reports.

General level (1)

Commercial glass eel fishing is forbidden in 3 of the 5 countries, but time-series of scientific surveys are used to infer indices of recruitment. Therefore, we applied the quality evaluation procedure to these scientific data.

Yellow and silver eel catches are aggregated in two of the countries, so clearly these do not support separate assessments of production and escapement. One country reported a time-series of scientific survey of silver eel, and this was included in our evaluation, similar to our approach to scientific surveys of glass eel recruitment.

Detailed level (2)

Detailed descriptions of the data collection programmes were not provided in any of the Country Reports. Several Country Reports referred to previous reports or scientific publications which provide greater detail on the data collection programmes, particularly for scientific survey programmes. However, there was not time during the WG to research these additional sources. Therefore, the information in the table can be regarded as the minimum available information. It is anticipated that the use of the DQEC in the production of Country Reports in future years will improve this procedure.

Representativeness of the data

Few reports detail whether the data represent those of all fishing groups (i.e. commercial, recreational), and therefore neither that the data are a known proportion of group sampled. The indicators of the recreational and/or non-commercial fishers are generally missing for each eel stage, and no estimation is made in this case. Nothing is reported regarding the levels of illegal fishing for any of the stages and indicators, and therefore no attempts are made to account for this in reporting total catch (i.e. licensed reported + licensed unreported + illegal).

Precision of the data

The fishing fleets are rarely described in detail. In contrast, the units of the data are always reported.

Most country reports note that there have been changes in the dataseries, such as measuring weight in imperial then metric scale, ands changes in regulations. However, no country reports provide details of methods applied to standardize or calibrate the time-series to take account of these changes. Such breaks in the dataseries will become especially evident from 2009 onwards as a consequence of the implementation of the EMPs.

Accuracy of the data

Few of the reports provide any indication of procedures applied to verify the reported data.

Finally, there is a discrepancy in the information provided and in its level of detail between different Country Reports. Therefore, in addition to increased reporting of information, a coordinated approach to reporting data quality will facilitate future global evaluations of data quality.

These issues with the assessment of data quality, and the data quality itself, are summarized in the ICES table template (Table 2.11), and will be reported to the appropriate ICES groups.

Table 2.10: Data Quality Evaluation Criteria checklist, illustrated with evaluations for glass eel catch, effort and cpue information from five Country Reports (vWG09).

PROCESS OF EVALUATION OF QUALITY FOR 5 COUNTRY REPORTS					
STAGE			Glass eel		
		Scientific	Catch	Effort	Cpue
Necessary INFORMATION	CONDITIONS required		glass eel fishing is forbidden in 3 of 5 countries		
Scale 1			restocking capture		
General level: global, country					
0 Does the data, results exists all?		y,y	y,y	y,y	y,y
01 What spatial level available? (C, B)	survey site, catch	site 2	District 2	Basin, River	Basin, River
02 What time period? (punctual, series)	time unit	annual 2	annual 2	annual 2	annual 2
	continuous or broken	broken 2	broken, not known	broken, not known	broken, not known
Scale 2					
Detailed level: local, Basin, tributary, reach					
1Origin: Method of collection	Detailed protocol of collection available?	n, y	y,y	n y	n y
11 type of Monitoring system		y,y	y,y	n y	n y
12 Who is Responsible?		y,y	y,y	y,y	y,y
2 Location (spatial coverage, detail C, B)	clear and appropriate limits	y,y	y,y	y,y	y,y
3 Period consistency, year, season	clear and appropriate limits	n, y	y,y	y,y	y,y
4 stage	specified or aggregated	y, y	y,y	y,y	y,y
5 Representativeness of the data					
50 Fishermen catégory	is there a list of categories?	n/a	y, n/a	y, n/a	y, n/a

PROCESS OF EVALUATION OF QUALITY FOR 5 COUNTRY REPORTS					
STAGE			Glass eel		
		Scientific	Catch	Effort	Cpue
51 Sample or whole population?	is the protocol of calculation described	y, y			
52 Whole population	or is the whole population included		y, n/a	y, n/a	y, n/a
53 Unknown					
54 All fisher categories described?					
55 Illegal and undeclared? Estimation	is there any measure of this, and use?	n/a 2	n, n/a	n, n/a	n, n/a

Table 2.10 cont.: Data Quality Evaluation Criteria checklist, illustrated with evaluations for glass eel catch, effort and cpue information from five Country Reports (vWG09).

PROCESS OF EVALUATION OF QUALITY FOR 5 COUNTRY REPORTS					
STAGE			Glass eel		
		Scientific	Catch	Effort	Cpue
6-7 Precision of the data					
61 fleet, métier	is there clear definition and content	n, y	n, n/a	y, n/a	y, n/a
62 Unit	what are these?	counts 2	kg 2	day2, hour	kg day2 or hour
7 Series, dimension	definition of limits	y	n 2	n 2	n 2
71 Time coverage		y	y2	n 2	n 2
72 Spatial coverage		y	y, 2	n 2	n 2
73 Changes, What, Why, dates	different protocols,	y	y2	y2	y2
	evolution of fishing power		not described, described	not des., described	not des., described
8 Accuracy of the data					
81 of basic data	mode of verification, correction,	n	no / n/a	no / n/a	no / n/a
82 of results = aggregated data	protocol of calculation	n/a	no / n/a	no / n/a	no / n/a
9 Overall Quality = Reliability (level), value					

Table 2.11: ICES Data Quality Table Template completed for Eel.

Stock	Description of Data Problem	How to Be addressed?	By who
Eel Anguilla	None of the reviewed country reports provide enough information to fully evaluate data quality Catch, effort and cpue data are often under-evaluated or missing completely. Where available, they are not clearly reported by biological stages (glass eel, yellow, silver), by category of fishery (commercial, recreational) and by appropriate management unit. Under-reporting was noted but not quantified, whereas illegal fishing was not recorded and no attempt was made to raise total catch reports to account for either	Provision of detailed information along with every dataset reported in the country report that is used for assessment, either nationally or internationally. This provision will be facilitated by the compilation of data quality 'metadata', which is described in the form of a checklist table developed by WGEEL	The authors of the Country Reports, with support from those providing assessment data

2.8 Conclusions and recommendations on Chapter 2: Data and Data Quality

2.8.1 Data statistics and trends

Recruitment series in glass eel and young yellow eel demonstrate different trends apparent by the 1960s. Declining trends are evident for all time-series with a shaper decrease in 2008 and 2009 with a drop of around 50-6–%.

All glass eel recruitment series demonstrate a clear recruitment decline since about the 1980 without sign of recovery. For the different areas (Baltic, continental North Sea, continental Atlantic, British Isles, and Mediterranean), levels have dropped to between 1 and 9% of the pre 1979 levels. The North Sea yellow eel recruitment series have been declining continuously, since the 1950. The Baltic series have dropped to less than 10% of their initial values between the 1950s and 1970s and now remain at a low level.

There needs to be an improvement in the data collected and reported, particularly on landings and on stocking. Hopefully, the traceability requirements under the EU Regulation (Comm 1100/2007) and CITES will improve this situation.

The WG anticipates that more data and information should become available in the near future as a consequence of the implementation of the eel management plans.

2.8.2 New data

The WG compiled estimates of eel production and silver eel escapement, management plans and the amount of glass eel required by the Member States for their management actions, and list of proposed management actions. Not all Country Reports provide these data, in part or in full, and it is not known by the Working Group at this stage if they are included in the Eel Management Plans.

2.8.3 Data quality

Basic data of catch "C" and effort "f" and the main fishery indicators: C total (landings/ fishing mortality), f total, and abundance index (generally cpue) for eel are very often under-evaluated, if not missing. Moreover, they are not clearly reported by biological stages (glass eel, yellow, silver), by fishing categories or by appropriate management unit. The indicators from recreational fishermen are generally missing and no estimation is made in this case. Nothing is known about poaching. The fishery indicators for eel are not associated with a "quality value" and their representative value and accuracy is globally unknown. As a consequence, the trend in abundance appears largely because of the drastic loss in recruitment but the whole landings and fishing effort (basically number of fishermen) are unreliable.

None of the evaluated Country Reports have full and/or complete information necessary to evaluate the quality of the data used for national or stock-wide assessments of the status of the stock.

2.8.4 Recommendations

It is recommended that;

> the effects of management actions on those glass eel fisheries that provide recruitment indices are critically analysed with the objective of calibrating future data against historical data collected prior to the implementation of EMPs.
>
> countries include/provide the basic indicators that are required for the Country Reports with an evaluation of their quality (reliability), and at least indicate clearly if these are unavailable or unrecorded.
>
> countries collect and report information on the quality aspects of their data and indicators, and use the checklist table as a form of metadata for all data and indicator series for future Country Reports. Reference should be made to the FAO guidance and Indicang reports (Castelnaud and Beaulaton, 2008) for sampling method quality considerations (Caddy and Bazigos, 1985; FAO, 1999; Evans and Grainger, 2002).

3 Stock assessment and post-evaluation

Chapter 3 continues the line of development commenced in the 2008 Report, the concept of post-evaluation and stock assessment at the international level, discusses how a post-evaluation might be structured, manages expectation for silver eel monitoring by 2012 and presents a demographic model. (ToR a, c and d).

a/ assess the trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;

c/ develop methods to post-evaluate effects of management plans at the stock-wide level;

d/ develop methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures.

3.1 Introduction

The EU Council Regulation (EC) No 1100/2007 Article 9 requires the member states to report and evaluate the effectiveness and outcome of the national eel management to the Commission every third year, starting 30 June 2012. The reporting every third year will change to a reporting every sixth year from 2018 onwards. The reports shall provide the best available estimates of:

> for each Member State, the proportion of the silver eel biomass that escapes to the sea to spawn, or the proportion of the silver eel biomass leaving the territory of that Member State as part of a seaward migration to spawn, relative to the target level of escapement of at least 40% of the silver eel biomass relative to the best estimate of historical escapement that would have existed if no anthropogenic influences had impacted the stock.

For Member States not having submitted management plans, or where the plans are pending approval, the level of fishing effort that catches eel each year, and the reduction effected shall be reported;

- the level of mortality factors outside the fishery, and the reduction effected;
- the amount of eel less than 12 cm in length caught and the proportions of this utilized for different purposes.

Measurements of present silver eel escapement are sparse, imprecise and usually limited to freshwater. No method exists for measuring escapement from brackish and coastal waters. Historical data on silver eel escapement are essentially missing. Knowledge of the production of eel from saline environments was the subject of a recent SG (SGAESAW) which recommended a further SG on developing assessment methods.

Even when data are available, the large time-lag between the recruitment and the silver eel escapement means that the escapement of silver eels in three years time to a large extent is determined by the recruitment before the national eel management has been implemented.

This implies that the evaluation should use means other than direct data collection, and that the expectation of seeing a recovery to the historical target level in this short period is nil. Even with drastic reduction of the anthropogenic mortality, the 30 years of decline in recruitment cannot be expected to recover in three years in a species with a >10 years generation time.

In addition to the evaluation on a Member State level required by the EU regulation the ToR of ICES WGEEL requires an assessment of the stock at an international level. This assessment should ideally be made with a BACI (Before, After, Control and Impact) design, to evaluate the effect of management on the recruitment of the *A anguilla* stock. Evidently the CI part of this comparison is not possible for a panmictic species. What could be done is to compare *A anguilla* and the sibling species *A rostrata*. With the assumptions that the decline is caused primarily by anthropogenic factors and that the management on the two continents are different such a comparison could be meaningful.

Otherwise a comparison of escapement or yellow eel abundance before and after management is the only possibility. Evidently this will be even more hampered by lack and uncertainty of data than an evaluation on a national level.

In the following, the timing, spatial scale, and the means to post-evaluate will be discussed, and a discussion on the methodology initiated.

3.2 When?

Following the reporting by Member States to the EU in 2012, it is anticipated that the first post-evaluation of the outcome of the implementation of the Regulation and its Eel Management Plans will be required. It is for this evaluation exercise of 2012 that we attempt to develop a methodology in this chapter. This chapter is a logical follow-on from Chapter 3 in the WGEEL 2008 Report (ICES 2008a).

Probably the best approach will be sensitive both to the impact of eel lifespan on what can be assessed, and to the quality of available data. As the changes in mortality on various stages of the population that follow from management measures begin have impacts on subsequent population stages that are either more important to measure, or more easily measured, so it may be that more appropriate measures can be developed for subsequent rounds of EMP submissions. It is important to recognize that management measures will, in many cases, not produce a measurable response by 2012, but whereas in some cases this will be because the measures were inadequate, in others it will be because the time-scale over which the response is being measured is too short. The likelihood of detecting measurable change will depend on the component of the population which is directly affected by the management, the component of the population in which response is sought, and the generation time of the eel in the locality. The model we develop here (Section 3.6) explores some of the likely time-scales involved in detecting the response of different population components following differing management and in different regions of Europe. To predict the response of management measures beyond 2012 requires estimation of recruitment values, which introduces a significant degree of uncertainty. However, for a future post-evaluation exercise information on actual recruitment could be incorporated.

3.3 Where (what scale)?

There are two plausible scales of evaluation, the Eel Management Unit (EMU) level and the European Union level. However, whereas on the one hand the continental stage of the eel is necessarily spatially distinct in nature, with spawner output reflecting local recruitment and the unique properties of the particular EMU, on the other oceanic processes can only be evaluated at the level of the entire European eel stock.

Accordingly it is not a simple matter to decide on the most appropriate scale of post-evaluation.

The local scale evaluation must be based on the measures reported in the management plans, while a Europe-wide evaluation would ideally be a summation of the data from the individual management plans. Such an approach will be rendered impossible if all the management plans are unable to deliver the necessary data, and would in any case necessarily be compromised by the weakest dataset among all the management plans. Furthermore, the EU Regulation requiring eel management plans covers only a part of the range of the European eel. There remains Norway, Russia, Iceland, non-EU members in Eastern Europe, the southern and eastern Mediterranean and the Atlantic coast of northern Africa for which details of eel populations are largely unknown and management measures are uncontrollable. The contribution to overall recruitment from this section of the population may continue to decline irrespective of successful management measures in the European Union. The degree of reliance, either currently or in the past, of the overall stock on recruitment from non-EU eels is unknown, but is important in terms of the scope available for restoration of recruitment.

The foregoing illustrates that silver eel outputs and glass eel inputs cannot be adequately known for the entire range of the European eel. Accordingly the summation of local estimates does not form an effective method for international post-evaluation, and instead a simplification involving average parameters must be deployed. However, the lack of a direct connection between local silver eel escapement and subsequent recruitment together with the wide range of growth rates (and presumably mortality rates) exhibited across its European range, mean that average parameters must necessarily disconnect the evaluation from the true processes involved, and as such may generate unreliable conclusions. Eel populations at the fringes of the range are likely to be particularly poorly fitted by this large-scale modelling exercise. An intermediate possibility is to arrange post-evaluation on a regional basis (Mediterranean, Biscay, British Isles, North Sea and Baltic). While this might reduce some of the averaging errors, it could not eliminate them and would still involve some unrealistic simplifications.

So, in conclusion, while approaches can be made to post-evaluation, none can be perfect, and a problem for post-evaluation remains, and is likely to continue to remain for the foreseeable future.

3.4 What?

What component of the eel population should an evaluation focus on? According to the European Regulation on Eels each EMP must make an estimate of the biomass of pristine spawner escapement from the Eel Management Unit. The target level of escapement is defined as 40% of the estimated pristine escapement level. The ultimate evaluation of the success of management plans then must be in terms spawner biomass. However, because of the long lifespan of eel, spawner escapement will not, in the short to medium term, necessarily be the most sensitive metric of the impact of management measures, and in most cases should be expected to continue to decline, even in the aftermath of positive management methods, for some years, as it reflects the recruitment of glass eels from previous years. Accordingly other components of the eel population (recruits or subcomponents of the yellow eel stock) may be more appropriate to assessing the initial impact of management measures, although their relationship with the ultimate measure of spawner escapement will remain uncertain.

The component of the population that is expected to respond soonest to management measures will depend on the management measures adopted. Measures related habitat quality or extent may affect all components of the population slowly, and in an approximately similar way, but if a glass eel fishery is reduced then an immediate impact on young yellow eels is the first predicted response. If a stocking programme is instituted than the most immediate response will be in young yellow eels. If a yellow eel fishery is curtailed, then it is among large yellow eels that a response should be initially sought. Where a silver eel fishery has been suspended clearly it is among spawners that the initial impact will occur. As a precautionary principle, an initial increase in silver eel output as a consequence of changes in fishing pressure on silver eels in an EMU should be regarded as a temporary achievement only, as recruitment must be expected to continue to remain at historical lows until silver eel escapement begins to increase all over Europe (which cannot be expected to be the immediate response to EMPs since many have management measures directed at younger life-stages).

When considering current performance in one component of the eel population it is necessary to consider the level of recruitment that pertained at the time appropriate to the stage in question (i.e. 10 years ago if the component being assessed is the spawning escapement of 10-year old silver eels). The relation between the (time-lagged) recruitment and the life stage under consideration is proportional, unless density-dependent processes occur. Density dependence might be a factor contributing to dispersal within rivers, to growth, mortality and to sex differentiation (see ICES; 2003 for an overview). Although the concept of density-dependence is frequently cited in eel literature, evidence *for* and knowledge *of* the processes involved is incomplete. In the absence of conclusive scientific evidence, the prudent approach to stock management is to assume that density-dependent processes do not occur (Dekker 2008). Consequently, scientific advice (ICES 1999 to 2008) has focused on a reduction of anthropogenic impacts, and advised to aim for a substantial increase in spawner production. In the specific case with which we must deal here, that of accounting for recruitment trends in the post-evaluation of management actions on subsequent spawner escapement, we must examine the consequences of the assumption of the absence of density-dependent effects (Annex 3). When recruitment is increasing, precautionary approach requires an assumption of an absence of density-dependence in either growth or survival in the population, i.e. that the ratio of recruits to subsequent spawners be regarded as 1:1. Thus, if the recruitment trend in the appropriate period was a doubling, so a doubling of subsequent spawner escapement would be regarded as neutral. When recruitment is falling however, the precautionary assumption has to switch to allowing for density-dependent effects, or there is a danger that density-dependent lack of parity between recruits and subsequent spawners will be taken for a positive impact of management measures. The likely scale of density-dependent effects will vary between EMUs, and is not well known. Given that recruitment has been at a historical low for some years, however, it is thought likely that density-dependent effects will not currently be strong, and in such circumstances the assumption of no density-dependent effects is not likely to lead to large errors in post-evaluation. Nevertheless we caution that where the scale of density-dependent effects is unquantified any post-evaluation of spawner output following a period of downward trend in recruitment must be regarded with circumspection.

A further consequence of the indirect relationship between spawner output and subsequent recruitment at the local level is that it is quite possible for EMUs to appear to be performing well (or badly) entirely by chance, if a Europe-wide estimate of recruitment is used. Indeed where the assessment of EMU performance is sensitive to local recruitment levels, as will usually be the case, chance effects cannot be ruled out in the assessment of EMU performance unless recruitment is reported locally. Given the assumption of the 1:1 recruit to spawner ratio, the reliability of the recruitment estimate is important as the reliability of the escapement output.

An alternative to direct measures of stock is to estimate the impact of current management measures via changes in mortality levels. To achieve this values of recruitment trend, total catch, and eel lifetimes (oceanic and continental) and natural mortality are required, whereas fishing mortality is an output. Necessarily considerable simplification of eel biology is required to conduct this process, with reliance of mean values of widely varying parameters and largely decoupled processes (i.e. escapement and recruitment). To some extent these simplifications can be reduced by assessing impacts on a regional basis. This is explored in more detail in the "How" Section 3.5.

Because there is significant spatial variation in the generation time of eel (or the time it takes to complete a full revolution of the life cycle) there will be concomitant variation in the speed of response that can be expected from individual EMUs to management measures. These will be in proportion to growth-rates/maturation schedules, and in general southern areas can be expected to respond the most rapidly, where the entire life cycle may take as little as 8 years, whereas in some northern areas generation time might be more than 30 years. The likely scale of response, various changes in mortality at different life stages and the range of response times across different areas of Europe can be seen in the heuristic model presented below (Section 3.6)

We present a chain of evaluation which demonstrates preferred components of assessment of the success of management measures (taking into account trends in recruitment during the preceding period appropriate to the locality under scrutiny). In general it is recognized that the amount of information collected in the field might not yield estimates reliable enough to assess the effects of management measures. This is in part because of the short time span (2009 to 2012), and because of the delayed and restricted implementation of management measures. It is particularly unlikely that enough information can be obtained to detect significant changes in the ultimate measure, that of spawner biomass, by 2012. Where a positive impact of management measures cannot be identified, we suggest that evaluation must move further down the chain of evaluation to a component of the population that can be measured with sufficient confidence. If there is insufficient confidence at any of the stages of evaluation, then the precautionary approach must be invoked: because the management plan cannot be demonstrated to be succeeding then management efforts to restore the stock must be increased.

3.5 How?

The section on what to evaluate to a large extent also implies how to do the evaluation. It is important that evaluation is founded on field data with assured quality. The large natural variation in most measures related to eel monitoring – glass-eel recruitment, escapement, fishing mortality, sex-ratio, etc – makes it necessary to consider the statistical power of any comparison in time and space.

Below, a decision process is presented based on the direct comparison of the trends in regionally compiled monitoring data to the observed recruitment time-series with the appropriate time-lag. This method is straightforward when there is a statistically significant trend in the data. Otherwise the evaluation is undetermined and the precautionary approach has to be employed.

The statements about management coming out from this decision process don't give any information on what is working or not in the management. To explore the causes the simple exploratory tool presented below might be useful. With this model hypothetical outcomes of different management options can be studied. The model also gives an alternative for evaluating the probable effect of already implemented management actions in retrospect. This may be the only alternative in some cases where field data are lacking, but great caution should be used in interpreting model results and they can never replace monitoring data.

3.5.1 Recovery?

The first stage of the post-evaluation is to assess whether the stock has recovered/is recovering and this will need to be undertaken at the International level. If the stock has recovered then management needs to continue to ensure that the recovery of the eel stock is not jeopardized (**M0**) by human activities. If the stock has not recovered, then evaluation of the measures should be undertaken at a local scale (Eel Management Unit (EMU)) by comparison of eel abundance at the silver eel and/or yellow eel stage and/or by a comparison of mortality rates.

3.5.2 Post-evaluation based on trends in silver eel

Post evaluation should ideally be done at the silver eel stage by comparing the output in 2009 with that measured in 2012. If there are no estimates of silver eel output yellow eel data are acceptable. The main limitation of using the yellow eel stage for evaluation of the measures is that mortality post-evaluation is still possible i.e. from turbines or fisheries as the eel migrate seaward. Thus these evaluations must be undertaken on those catchments where there is no additional anthropogenic mortality i.e. the assessment must be done on those catchments where there is free access to the sea, the only unaccounted mortality being natural and therefore assumed to be the same pre and post the intervention of measures. It is important also to consider the time period over which the intervention should be measured. For example if management action was to reduce fishing pressure in the glass eel fishery then for an evaluation in three years time the effect would need to be measured by sampling the yellow eel population as it would be too soon to see any impact in silver eel escapement.

If it is possible it would be better to compare the output in the three/four years prior to the intervention with those in the period afterwards i.e. the mean silver eel output in 2007–2009 with that in 2010–2012. [It may be possible to use a longer time-series prior to the intervention in 2009 to increase the precision of the estimate; however this needs to be confirmed through a power analysis.]

As recruitment has been falling account needs to be taken of the decline in recruitment over the relevant time period (mean age at migration for silver eel and mean age of the yellow eel sample for resident eel). Ideally, the recruitment trend used should be measured over a similar spatial scale to that of the stock. If that is not possible then regional or EU-wide values can be used (Annex Table 2.1). It is, however, very important to be aware that if recruitment is not measured at the EMU scale, that an average regional or EU-wide value will be likely to introduce large error into the estimation, potentially invalidating the evaluation.

To post evaluate the measures in the management plan, two factors are determined:

1) the difference in the stock (ΔS_{EMU}) pre (S_{EMU}^{09}) and post (S_{EMU}^{12}) intervention

$$\Delta S_{EMU} = S_{EMU}^{12} - S_{EMU}^{09}$$

Where S can be measured either in terms of biomass or numbers. Preference should be given to analysis using numbers as this avoids 1) confusion with changes in gender ratio and 2) in an ageing population where recruitment is virtually zero and where instantaneous mortality is lower than the instantaneous growth rate, biomass may increase from to t_n t_{n+1}.

Note: the spawning-stock biomass escaping may be only weakly related to the number of spawners, because of the relationship between gender and growth and population density and the relationship between gender and mass of silver eels. The relative importance of the number vs. the biomass of escaping silvers is currently unknown.

and

2) the difference in the mortality rate (**ΔM_{EMU}**) pre (M_{09}) and post (**M_{12}**) intervention

$\Delta M_{EMU} = (S_{EMU}^{12} / R_{EMU}^{12-n}) - (S_{EMU}^{09} / R_{EMU}^{09-n})$

Where **R_{EMU}^{x-n}** is the recruitment index n years prior to the estimate in year x, and n is the mean age at silvering.

These two factors are then combined in a matrix to provide the following recommendations as to whether or not the EMU plan is working (Table 3.1).

If data are available for individual years the mean **ΔS_{EMU}** and **ΔM_{EMU}** should be determined and the mean values used in the assessment.

Table 3.1: Recommendations for management following post-evaluation of the EMU measures.

	Mortality ↗ or → (ΔMEMU ≥ 0)	Mortality ↘ (ΔMEMU < 0)
Stock ↗ (ΔSEMU >0)	M3	M1
Stock → or ↘ (ΔSEMU ≤0)	M3	M2

*** in the absence of knowledge of density-dependence effects this evaluation must be regarded as provisional.**

Where:

M1: EMU plan has a positive effect, but it is possible to take further management action to increase silver eel output from the EMU as the stock has not recovered.

M2: EMU plan has a positive effect but additional measures are needed to achieve stock recovery.

M3: Measures are not working. Further measures urgently needed.

When using yellow eel data, it is suggested that abundance of yellow eel be used, the simplest approach being mean density of yellow eel * available wetted area.

If there are no data available then the precautionary approach should be applied and the international scientific advice adhered to – reduce all anthropogenic mortality to as close to zero as possible until a recovery is achieved.

3.5.3 Post-evaluation based on mortality rates

A post-evaluation of the stock status can be undertaken using a threshold mortality estimate pre and post intervention in 2009. This threshold corresponds to the breakpoint of cumulative mortality over the lifespan where recruitment decline is expected to stop. Aström and Dekker, 2007 proposed a method to estimate this figure based on four main assumptions. The natural mortality rate is considered constant over the lifespan. The historical trend of recruitment is smoothed with an exponentially decreasing line. Silver eels from the zone under consideration (North Sea, British Isles, Atlantic, Mediterranean and Baltic Sea) are the sole contributors to the spawning stock (it is appreciated that this is not the case) and mature at one age (also not the case).

The threshold is calculated as follows:

$$T = cum(F+H) - D(\tau + \tau_{oc})$$

where $cum(F+H)$ is the cumulative fishery and anthropogenic mortality over lifespan, D is the exponential decrease of glass eel recruitment calculated on 1980–2009 data (y^{-1}) [Table in WG Report - Data section], τ the lifespan (y) and τ_{oc} the duration of oceanic migration (2 years).

Aström and Dekker, 2007 applied this model to "elsewhere than Gulf of Biscay" data of Dekker, 2000. In their study $cum(F+H) = 3.24$ corresponded to a fishing mortality of 0.54 y^{-1} during 6 years. Lambert, 2008 adapted it to the situation of the French Atlantic coast and took into account fishing and other sources of anthropogenic mortality. In that case, $cum(F+H) = 1.83$ (Table 3.2). The total lifespan was 16 years in the study of Aström and Dekker, 2007 and 9 years in that of Lambert, 2008.

Table 3.2: Duration and instantaneous mortality coefficient for different life stage in French Atlantic coast area (Lambert, 2008).

		Mortality coefficient (y-1)		
Eel life stage	Duration (y)	Legal fishery (F)	Other (H)	Cum mortality (y*(F + H))
Glass eel	0.25	3.3195	0.0693	0.847
Elver	0.75	0	0.0693	0.052
Pre-exploited yellow eel	3	0	0.0693	0.208
Exploited yellow eel	4	0.0156	0.0693	0.340
Silver eel	0.50	0.0069	0.0693	0.038
Escape	0.50	0	0,6931	0.347
Total				1.831

The threshold mortality (cumulative mortality over the lifetime) is then compared with the current value of $cum(F+H)$. The proportion of the mortality which needs to be reduced is ((1-$cum(F+H)$)/Threshold) (Table 3.3).

Table 3.3: Computation of cumulative fishery and anthropogenic mortality threshold.

	Astrom and Dekker, 2007	Lambert, 2008
Life span (τ)	16	9
cum(F+H)	3.24	1.83
Decrease of glass eel recruitment (D)	0.1538	0.0997
Threshold (T)	0.47	0.73
% reduction of mortality required to meet threshold.	85%	60%

To use this approach D (the exponential decrease of glass eel recruitment calculated on 1980–2009 data (y^{-1})) needs to be determined for the 5 geographical areas; North Sea, British Isles, Atlantic, Mediterranean and Baltic Sea together with an estimate of total catch/total stock and other anthropogenic impacts.

Table 3.4: Recommendations for management following post-evaluation of the EMU eel stock.

	Mortality ↗ or → (ΔMEMU ≥ 0)	Mortality ↘ (ΔMEMU < 0)	
		MEMU12>T	MEMU12<T
Stock ↗ (ΔSEMU >0)	E3	E2	E1
Stock → or ↘ (ΔSEMU ≤0)	E3	E2	EP

Where:

E1: EMU plan has a positive effect (but is it possible to take further management action to increase silver eel output from the EMU as the stock has not recovered).

E2: EMU plan has a positive effect but additional measures are needed.

E3: Measures are not working. Further measures urgently needed.

EP: It is uncertain what is happening and therefore the precautionary approach is to take additional measures and investigate what is happening within the EMU.

This approach was based on three main assumptions and though it has been reviewed and published it is important to investigate whether or not it can be applied at the smaller geographical scale. There is also need to investigate whether there are alternative approaches which could be used to set the mortality threshold (T).

3.5.4 Estimation of mortality

In this particular example a very simplistic approach to estimate mortality has been used, simply dividing the stock estimate by the recruitment index n years previous to estimate mortality us **(S_{EMU}^{12}/ R_{EMU}^{12-n})**. A more precise estimate can be obtained through mark-recapture studies, analysis of age/length–frequency data and through temporal changes in abundance. Further details on estimating mortality from length based analysis can be found in Dekker *et al*., 2006, Lambert *et al*., 2006 and Beaulaton, 2008.

3.5.5 Consequence of a 'No Density Dependence Hypothesis'

We emphasize that the evaluation process outlined above is reliable only where there is an absence of density-dependence between recruitment and subsequent spawner output. We demonstrate in Annex 3 the possible consequences of making an assumption of an absence of density-dependence if in reality density-dependence did exist, and illustrate how the strength of the true density-dependence between recruitment and spawner output could also influence the validity of the post-evaluation scheme suggested above. In some circumstances making an assumption of density-dependence could therefore be used as an excuse to take no (further) management measures, and in such a case we suggest that some attempt to justify the assumption should be made. In the light of these considerations we acknowledge the evaluation process will benefit from further development.

3.6 A demographic model – "WHEM"

To illustrate what effects in the escapement of silver eels can be expected; we developed an age-structured demographic model. It should be noted that this simple model is intended to give a realistic, but not an accurate picture of the state of the stock and the expected effects of management measures. In developing this model, the focus is on the post-evaluation foreseen for 2012. Results will be presented for the historical period, with predictions for the years up to 2015, which is the period in which the currently recruited year classes of glass eel dominate the production of silver eel. That is: no assumption on future trends in glass eel recruitment was required.

3.6.1 Model inputs

Has an annual time-step, site-specific parameter values and explicitly including:

variable annual recruitment (index), as observed in the past;

sex ratio;

body growth (initial body length + annual growth rate);

natural mortality;

anthropogenic mortality targeting glass eels;

anthropogenic mortality targeting yellow eels (mortality rate and minimum landing size);

anthropogenic mortality targeting silver eels (mortality rate and minimum landing size);

silvering processes;

length–weight relationships.

All of these parameters, except for the historical trend in recruitment, have been set at realistic values. This simple model is programmed in excel, and can be downloaded at http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=75. In the excel version, all parameters (except recruitment trend) can be set by the user.

3.6.2 Model outputs

The model provides estimates of the amount silver eel escapement by sex as a consequence of different management scenarios.

3.6.3 Model tuning

The model was explicitly tuned for 5 European macro-areas (i.e. Baltic Sea; continental Northern Sea; British Isles; continental Atlantic Ocean; Mediterranean Sea) characterized by different eel ecology and fishery.

Variable annual recruitment derived from Chapter 2.

Body growth

We assumed initial body size of 7 cm for newly recruited eels and annual site dependent body size increment. Respectively: 3, 4, 5, 5, 8 cm/yr for Baltic Sea; continental Northern Sea; British Isles; continental Atlantic Ocean; Mediterranean Sea populations

Natural mortality rate, M

We assumed annual natural mortality rate to be equal to that proposed in Dekker, 2000 i.e. M=0.138.

Anthropogenic mortality rate targeting glass eels, *Fg+Hg*

Anthropogenic mortality rate is a time and site dependent variable. Values have been considered constant until 2009 and susceptible to changes from 2010 onwards. Values of mortality up to 2009 were set equal to 0.3 for British and Atlantic populations and 0 elsewhere.

Anthropogenic mortality rate targeting yellow eels, *Fy*+*H*y and minimum body length affected by this mortality, *Ly*

Anthropogenic mortality rate is a time and site dependent variable. Values have been considered constant until 2009 and susceptible to changes from 2010 onwards. Coefficient of mortality up to 2009 was set equal to 0.25 for all the considered areas. Minimum body length where set equal to 25 cm in Mediterranean, 60 cm in Baltic and 30 cm elsewhere.

Anthropogenic mortality rate targeting silver eels, *Fs*+*H*s and minimum body length affected by this mortality, *Ly*

Anthropogenic mortality rate is a time and site dependent variable. Values have been considered constant until 2009 and susceptible to changes from 2010 onwards. Coefficient of mortality up to 2009 was set equal to 1 for all the considered areas. Minimum body length where set equal to 25 cm in Mediterranean, 60 cm in Baltic and 30 cm elsewhere.

Sex ratio

We assumed a balanced sex ratio, i.e. 50% of females at recruitment, for all areas.

Silvering processes

We assumed a knife function with silvering size set at 60 and 40 cm, respectively for females and males and a plateau level for instantaneous rate of silvering equal to 0.3 and 0.7, respectively for females and males.

Length–weight relationship

We assumed $W = aL^b$ where *a*=0.0001 and *b*=3.2 with *W* in g and *L* in cm.

3.6.4 Model results

We predict consequences of EMP implementation (aimed at lowering anthropogenic mortality) on spawner escapement of 2012. Three management measures are implemented, resulting in halving respectively glass eel, yellow eel or silver eel anthropogenic mortalities; a fourth scenario combines these measures, and halves all anthropogenic mortalities. Table 3.5 gives the results of management scenarios for these scenarios.

Given these scenarios the level reached for silver eel escapement in 2012 is not affected by glass eel measures, just because the time for a glass eel to become a silver eel is longer than 3 years. Depending of the trend in past recruitment, measures focusing on yellow eel and silver eel can result in a decreasing, stable or increasing trend of silver eel escapement. In all areas, the "50% decrease of all mortalities" scenarios give an increasing escapement with a ratio (2012 escapement divided by 2009 escapement) by 27% (North Sea) to 126% (Baltic). In a longer perspective (from 1980 to 2020 given a constant recruitment from 2009 onwards), these increases are moderate and in some case temporary (Table 3.6).

Noting these results, extremely accurate monitoring programmes will be required to detect any change by 2012.

Table 3.5: Results of the model by area and for different management scenarios for female silver eel biomass (orange line for business as usual control and red line for management scenario) and male silver eel biomass (light blue for business as usual control and dark blue for management scenario).

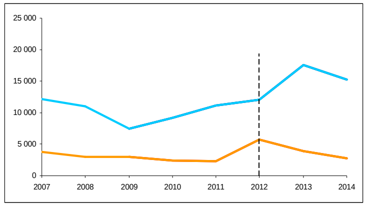
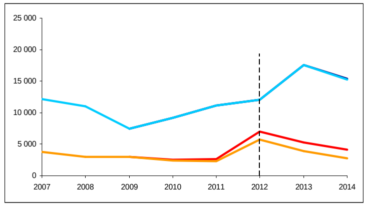
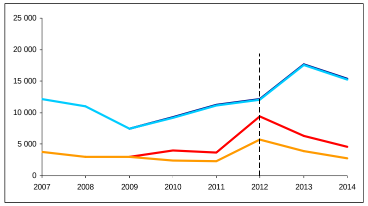
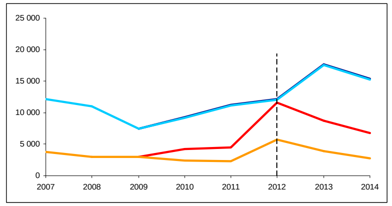
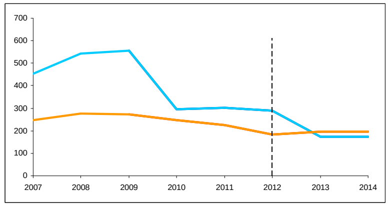
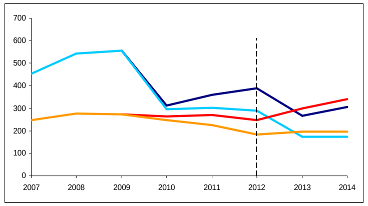
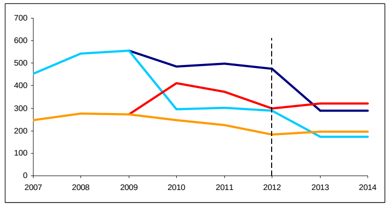
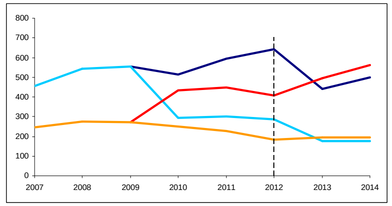
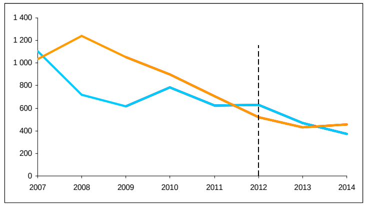
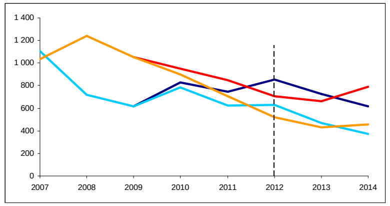
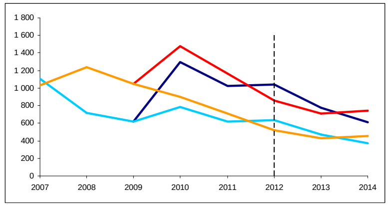
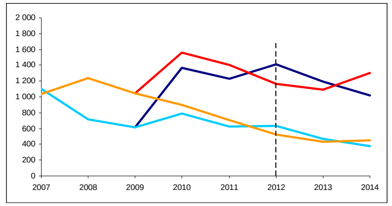
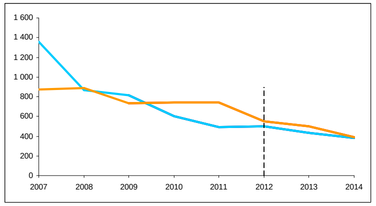
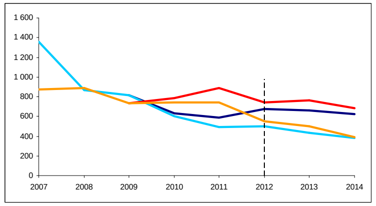
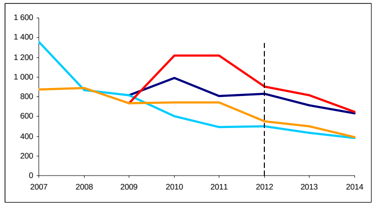
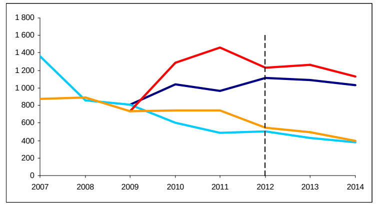
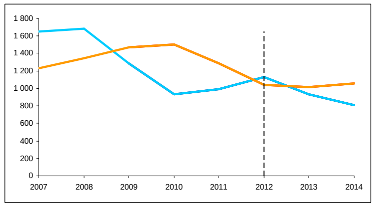
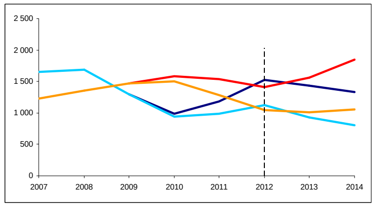
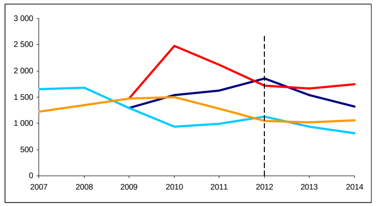
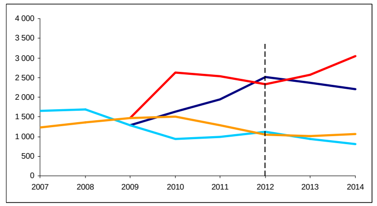
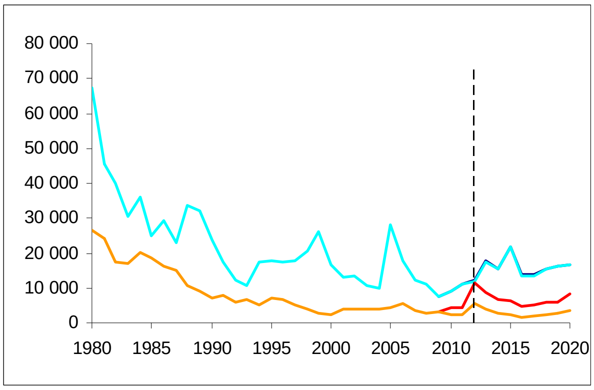
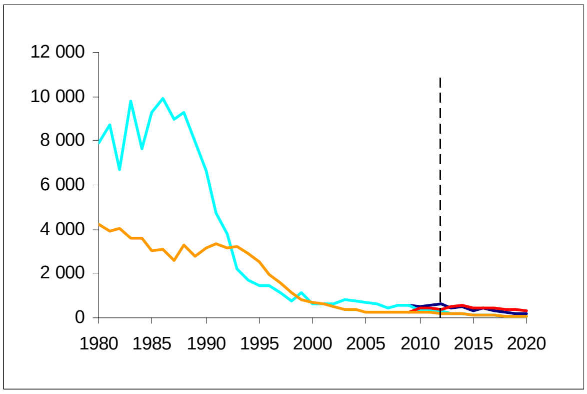
	50% decrease of glass eel anthropogenic mortality	50% decrease of yellow eel anthropogenic mortality	50% decrease of silver eel anthropogenic mortality	50% decrease of all anthropogenic mortalities
Baltic Sea				
North Sea				
British Isles				
Atlantic Ocean				
Mediterranean Sea				

Table 3.6: Results of the model presented for each area and for the management scenarios halving all anthropogenic mortalities. BAU is "Business as usual".

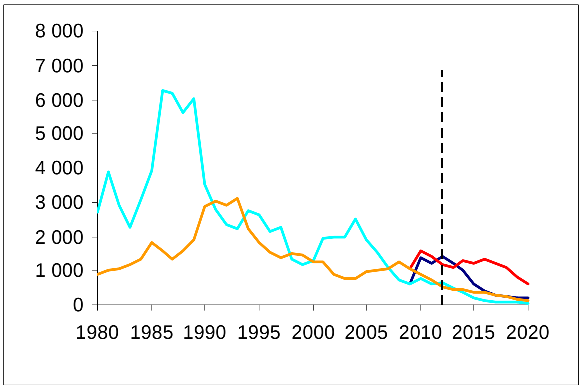
BALTIC SEA



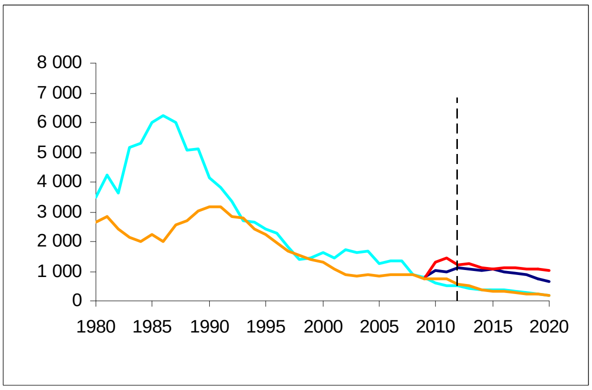
NORTH SEA



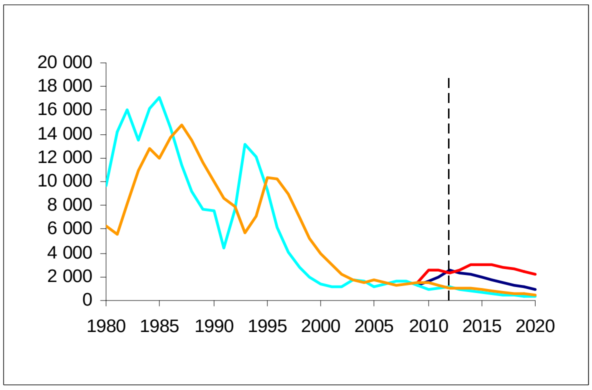
British Isles

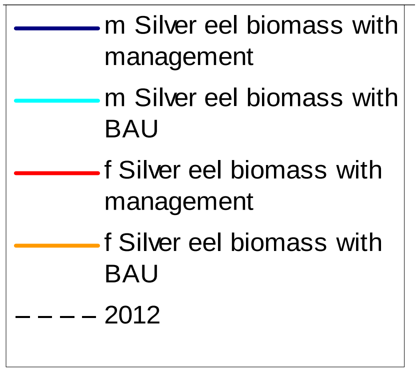


Atlantic Ocean



Mediterranean Sea





3.7 Conclusions and recommendations on stock assessment

The conclusions from the above analyses and reviews on stock assessment tools are as follows:

The implementation of protective measures in 2009/2010 is likely to lead to an improvement in survival and silver eel escapement. These improvements are not likely to lead to a substantial change in the status of the stock by 2012, because of the short time interval, the delayed effects of protection of the younger stages and indirect effects cascading through slowly. Noting the many uncertainties concerned and the low achieved precision in existing monitoring programmes, effects of protection will be difficult to detect in 2012.

A framework for post-evaluation of management measures, both at the scale of individual Eel Management Units, and on the international scale, has been worked out in this report, but practical experience is currently little available, and the development of the tools required is not planned. It is of utmost importance, that these developments are planned and initiated in time, to be available for the 2012 post-evaluation. Additionally, the collection of data (under the DCR and in relation to national EMPs) should be tuned to their usage in post-evaluations. This planning process requires the involvement and commitment from national and international responsible agencies (governments and research agencies). The research required (development of generic tools, testing in specific cases) goes beyond the capacity of WGEEL, but will require a dedicated research project.

The 2001 meeting of WGEEL (ICES 2002) recommended the formation of an international commission for the management of the European eel stock. Such a body could organize the monitoring and research on eel stocks and fisheries, serve as a clearing house for regular exchange of information regarding the resource status and facilitate/orchestrate management and research.

Noting the urgent need to plan and coordinate the data collection and tool development for the 2012 post-evaluation, this recommendation is re-iterated. Such an internationally coordinating and planning group could either parallel the North Atlantic Salmon Conservation Organization, NASCO, or fit into the scheme of Regional Advisory Committees RACs in the EU, albeit focused on a single most wide-spread stock (instead of a single region with many species) – an Eel Advisory Committee.

It is therefore recommended to set up a coherent process immediately, for the coordination and facilitating of eel management, for the development of assessment tools, for the collection of data, and for the coordination and standardization of the post-evaluations in 2012.

4 Advances in eel stocking

Chapter 4 reviews new data on stocking, the relative contribution/survival of stocked compared with wild eel and makes recommendations to optimize the use of a scarce and declining resource (ToR d and h).

d/ develop methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures;

h/ report on improvements to the scientific basis for advice on the management of European and American eel.

4.1 Introduction

Previous WGEEL report sections (ICES 2006, 2007, and 2008a) commented extensively on stocking theory and practice, and listed the various manuals and instruction documents on how to approach stocking. This earlier work is therefore not revisited unless relevant to a specific point – for theory and practice manuals the reader is referred to previous WG reports.

Stocking is listed as one management option in the regulation, and a measure in most of the Eel management Plans (EMPs) drawn up to meet the regulation, with a view using to stocking to supplement weakened stocks, or even replace lost ones, as an aid to meeting the long-term [silver eel escapement] targets. It should be pointed out at the outset of this chapter that this aspiration is now impossible on a stock-wide scale.

Even if the total catch of glass eel was available for stocking, in the best possible condition with minimized capture and handling mortality, only a fraction of the demand could be met. The most recent total compiled landings, for 2007/2008, are 71 t for the French glass eel fishery, which is the bulk of the European supply. The total for Europe for the 2008/2009 cohort is known to be less than this and may end up as ca. 40 t. Were stocking to be contemplated in all depleted River Basins to restore stocks to a level capable of meeting all silver eel escapement targets, the current supply is at very best an order of magnitude too low. Moriarty and Dekker, 1997 estimate a total Europe-wide requirement for fully stocking eel water at 644 t. Therefore, the current reality is that stocking with glass eel must be used judiciously and to maximum benefit in critically important eel areas.

The present chapter addresses the issues relating to stocking of eel and projected outcomes, with specific reference to new data available, updates on previous work, and further data from ongoing studies partly reported to previous WGEEL meetings. It is our intention to focus on this new quantitative information, compiling new and literature reported actual data, however limited, on known performance of stocked eel in extensive (wild) systems, and also on relative performance of stocked to like wild material where the two have been assessed as a mixed group.

4.2 New information on known outcomes of stocking available to WGEEL 2009

4.2.1 ICES study group on eel in saline waters

new information relevant to stocking glass eel - September 2009

This ICES convened study group, which took place immediately preceding WGEEL 2009, received a number of presentations containing insights relevant to stocking of eel. Key papers included:

An analysis of survival of aquaculture sourced eel in Denmark stocked at differing sizes (Pedersen, 2009),

Modelling of eel populations in Camargue lagoons (Bevacqua *et al*., 2009), identifying carrying capacity for initial glass eel settlement,

and several papers on Strontium-calcium ratios in eel otoliths informing, *inter alia,* debate on the survival of stocked eel and their contribution to spawner output.

Relevant ideas emerging from the workshop papers are briefly outlined in this section. Production of detailed summary proceedings from the Study Group (D Cairns, in prep) is intended for presentation to ICES by the end of October 2009.

4.2.1.1 Denmark

Stocking outcomes in the saline Roskilde fjord (Pedersen, ICES Study group on eel in saline waters, and unpublished results made available to WGEEL)

A stocking study in brackish Roskilde Fjord (12–18 ppt) aiming to find the outcome of stocking eel in a saline area was started in 1998. In total 50 603 eel of size 3 gramme and 50 268 eel of size 9 gramme were coded wire tagged (CWT) and stocked in 1998 and 1999. During the years 2000–2006 fisheries landings were examined for CW Tagged eel. When the stocked fish became silver eel the behaviour of stocked eel was compared with wild silver eels by re-marking captured CWT eel with Carlin tags and rewarding fishermen for returning the Carlin tag together with information on where the eels were recaptured.

The results demonstrate that during the period 2000–2006 a total 1834 CWT's were recaptured corresponding to an overall recapture rate of 1.8% of the stocked fish. Growth increment was estimated at between 30 and 75 mm per annum. The sex ratio of stocked eel was ca. 1:2 (M:F) in yellow eels but the proportion was reversed (50:1) in the catches of silver eel. This paradox in different sex ratios between yellow and silver eel is possibly a result of a high fishing mortality implicating that eels were caught before they could grow large. Identification of the eels at recapture demonstrated that 60.3% originated from the 3 gramme batch eel and 39.7% was from the 9 gramme batch.

The recapture rate of Carlin tagged silver eels was 28% in wild eels and 19% in the stocked. The same ratio between groups was recaptured as emigrating eel (56% in the southern part of the fjord and 44% in the northern part of the fjord) indicating that the stocked eels migrate toward the outlet of the Fjord with the wild silver eels.

Using the official landings and the frequency of CWTs in the examined catches a conservative estimate indicated that 10.3% of the 3g eels and 6.8% of the 9 g eels were captured in the professional fishery. Eel are also captured by leisure fishermen, but the catches of leisure fishermen are not registered and therefore unknown. The catch of leisure fishermen has in 1997 been estimated to be 26% relative to the registered professional catch in the whole country. Stocking saline Roskilde fjord with 3 gramme eel provides a possible catch to fishermen of 13% of a stocked cohort- Another 5% is estimated to leave the fjord as silver eels. The effect of stocking saline Roskilde Fjord is therefore of the order of 18% of a cohort of 3 gramme eel compared with 13% of cohort of 9 gramme eel.

4.2.1.2 Swedish Baltic Sea

Otolith microchemistry analyses reported to the ICES Saline waters SG:

Recently conducted chemical analyses (strontium-calcium ratios) of the otoliths from large numbers of silver eels, among them a tagged group, caught at the outlet from the Baltic Sea (Oresund) demonstrate that all recaptures were made in the predicted direction irrespective of growth origin (Sjöberg *et al.*, 2008). However, very few eels originated from freshwater, irrespective of being stocked or naturally recruited to freshwater (Clevestam and Wickström, 2008). Some 21% of the coastal eels were estimated to come from stocked eels, a figure in correspondence with the 27% given by Limburg *et al.*, 2003.

Thus, considerable numbers of Swedish freshwater stocked eels reach at least as far as the outlet from the Baltic Sea. Whether or not they also continue to the Sargasso Sea and support the spawning stock is beyond the scope of these studies.

4.2.1.3 Additional papers on otolith microchemistry

Tzeng presented a paper (Tzeng, 2009a) on migratory behaviour and habitat use of Japanese eel in the estuary as revealed by both conventional mark-recapture method and otolith elemental signature. Among many other issues, the habitat preferences and recapture rates were compared between wild and cultured eels stocked in a coastal lagoon. There were no obvious differences between eel of the two origins and both stayed mainly in brackish water, i.e. neither in the river nor in the fully marine environment.

Tzeng, 2009b discussed stocked vs. natural eels in the Baltic Sea, namely from Latvia. In this study they categorized sampled eels from three inland water bodies into stocked and naturally recruited from the life-history trajectories found in analysis of strontium-calcium ratios in the otoliths. Their results indicate a slower growth rate for stocked eels from two of the three habitats studied. However, they suggest that the differences found between wild and stocked eels might be influenced by the productivity of the growing areas where the eels spent most of their lives, which may not be reflected in the site of catch.

Hanel *et al.*, 2009 identified strontium-calcium-ratios as powerful tool to differentiate between wild and stocked also for the Western Baltic Sea. In a longitudinal gradient, including eels from Finland, he found a decreasing proportion of stocked vs. naturally recruited eels from east to west. Preliminary results point to a percentage of stocked eels in the Western Baltic of less than 20%. Considering the high stocking efforts in Western Baltic tributaries over the last decades, this would imply either still high natural recruitment or low survival of stocked eels.

4.2.2 The relative value of stocked and wild eel

From updated analysis of the Lough Neagh (Northern Ireland) input-output data to 2008. Presented to WGEEL 2009 by R Rosell.

The commercial eel fishery in Lough Neagh, Northern Ireland has two sources of stock, described below: A) local wild and trap-and transport upstream (="assisted migration"), and B) stocking with bought-in glass eel from elsewhere, (Severn Glass eel fishery in England).

A: Local wild and trap-and transport upstream The natural recruitment to this river and Lake system is partially trapped at a sluice gate and weir site at the tidal limit of the estuary of the river Bann and transported the 40 km upstream to Lough Neagh itself, thus resulting in a recorded time-series of local recruitment going back (with a break from 1946 to 1959) to 1936. The updated dataseries is shown in Figure 4.1.

It is also known, but not in quantitative terms, that at pre 1980 high abundances of glass eel there was considerable natural migration up the river channel in addition to the trap and transport activity. From 2000 onward with low natural arrival of glass eel to the estuary, this upstream migration is no longer observed as the annual mass migration of pigmented young of year eel noted before 1980. Stocking commenced with imported glass eel in 1984, in response to extremely low natural recruitment to the system in 1983.

B): Stocking with bought-in glass eel from the Severn Estuary fishery was particularly pronounced in the years 1984 to 1988 inclusive (Figure 4.1), resulting in a pulse of stocked eel, the majority of which should have passed through the commercial fishery and/or escaped from the system by 2008. Analysis of the fate of the 1984 to 1988 cohort only became possible in 2008, as known time-lag averages from glass eel in to grown eel outputs are 12–13 years for male silvers, 15–16 years for yellow eels (all female due to a market grade of 42 cm) and 17–18 years for female silvers.

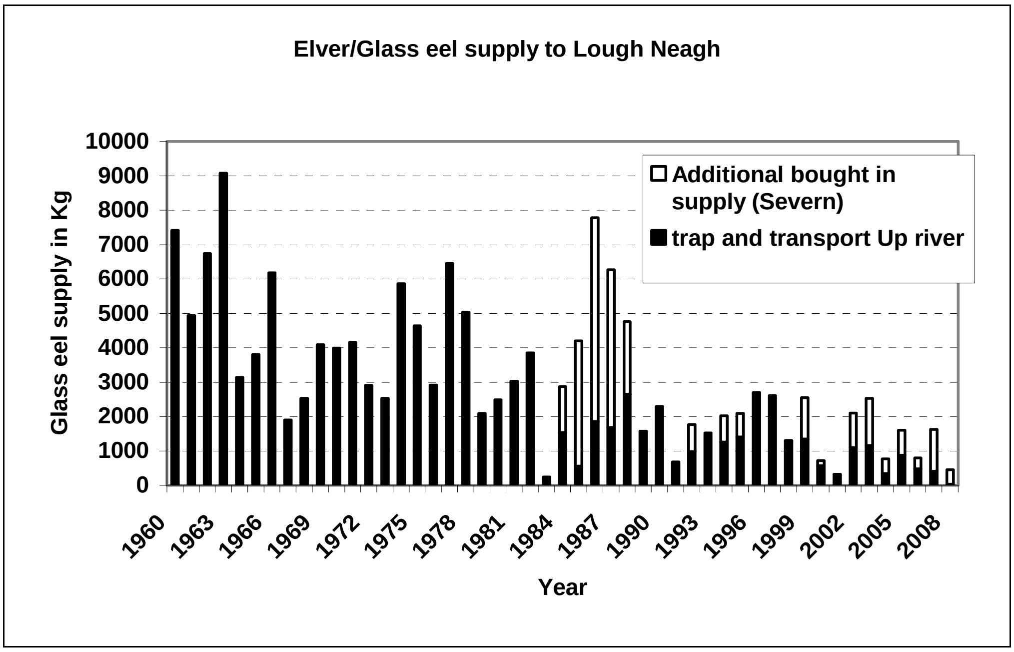


Figure 4.1: Recorded glass eel input to Lough Neagh, 1960 to 2008.

The contribution of this stocking pulse to the fishery catch and escapement output can be examined in a simple model, (Rosell, ICES 2008a). The model estimates the number of eels in the total of yellow eel and silver eel fishery, plus estimated escapement of male and females silvers, from catch weights and known individual weights of yellows, male silvers and female silvers. An estimated term for escapement can also be added based on the assumption that the efficiency of the present silver eel fishery as measured annually by mark-recapture since 2003 has not changed significantly over the past 4 decades.

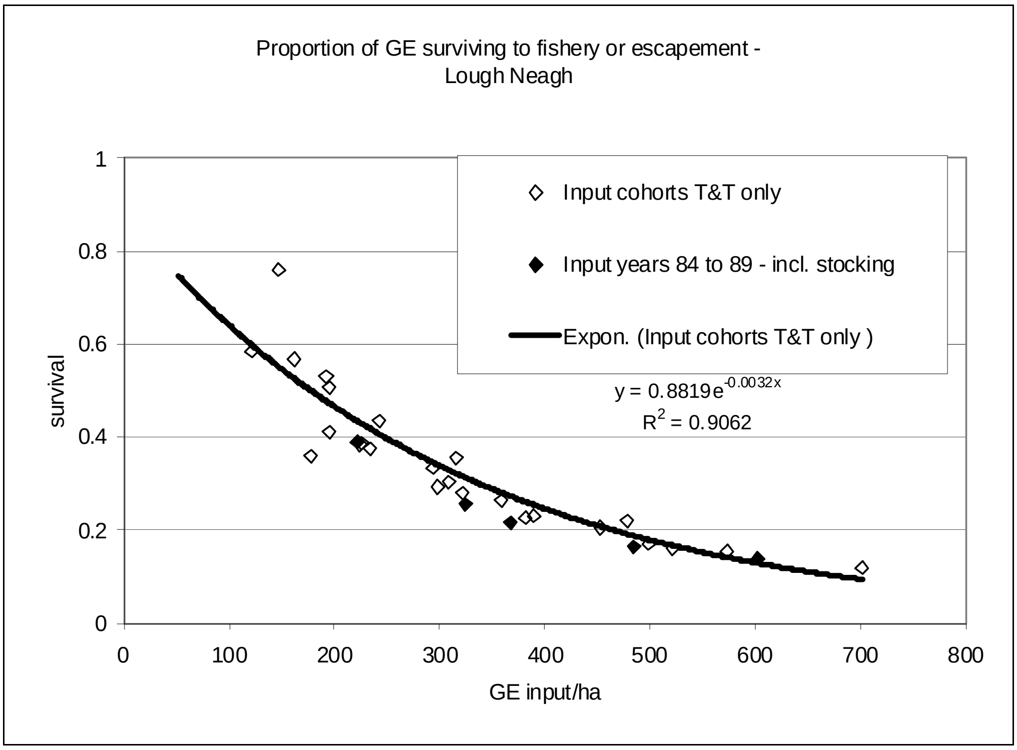


Figure 4.2: Modelled eel output of L Neagh (total number of eel) expressed per input density.

This model has been used to demonstrate a strong density-dependent relationship between input and output of eel, first demonstrated by WGEEL in its 2007 report. Figure 4.2 updates this relationship, now re-worked with a lower estimated male silver weight based on new data (120 g rather than 180 g). The model output demonstrates that whereas the years where stocking with non-local imported glass eel was high produce outputs for input density within the range of un-stocked years, the outputs for the stocked years are mostly below the fitted negative exponential trendline for un-stocked ones. One possible inference of this observation is that "stocked" material contributes at a lower rate than local trap and transported glass eel to the eventual output.

If one assumes that the lower output for stocked cohorts below mean output for the equivalent input density for un-stocked years is entirely as a consequence of reduced performance of stocked eel, a ratio of approximately 1:3 emerges as the worst case scenario for relative performance of non local stock to wild local supply. In reality, the true figure lies between this ratio of 1:3 and parity of performance, as no account can be taken of the number of wild eels evading trap and transport and making their way naturally to the lake, a factor which creates an artificially high estimate of the performance of trapped and transported eel input prior to 1980.

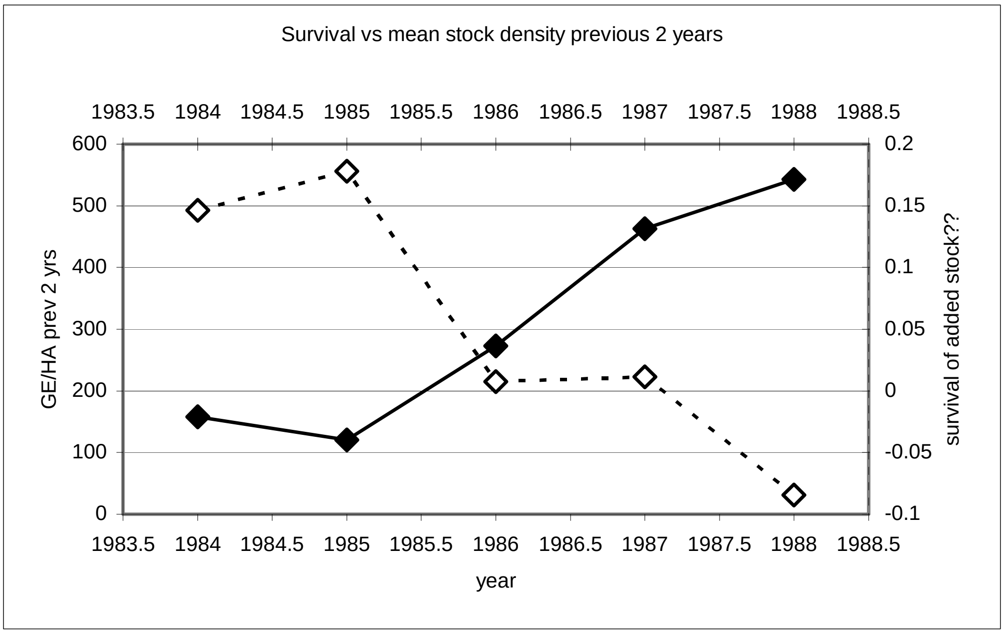


Figure 4.3: Modelled eel output of L Neagh (total number of eel) expressed per input density. Solid line: input previous two years, Dashed line: modelled survival of stocked cohorts.

Furthermore, analysis of modelled outputs for annual input cohorts of stocked eel, assuming the extreme scenario that the predicted output from natural trap and transport obeys the previous relationship and the stock accounts for only net measured output above this), implies that the first two years of stocking (1984 and 1985) following the natural recruitment failure of 1983 contributed far more to output than the subsequent 3 years (1986 to 1988). Modelled output plotted against the natural recruitment totalled over 2 years before stocking (Figure 4.3) imply that the "gap" in natural input was filled by stocking within 2 years, following which recovery of natural recruitment and assisted migration may by intraspecific competition or other mechanism have prevented any significant output from the 86 to 88 stocked cohorts.

The Lough Neagh model indicates that within the density-dependent relationship, maximum (number of eel) output is reached at an input of approximately 200 glass eel equivalents per hectare (Figure 4.4).

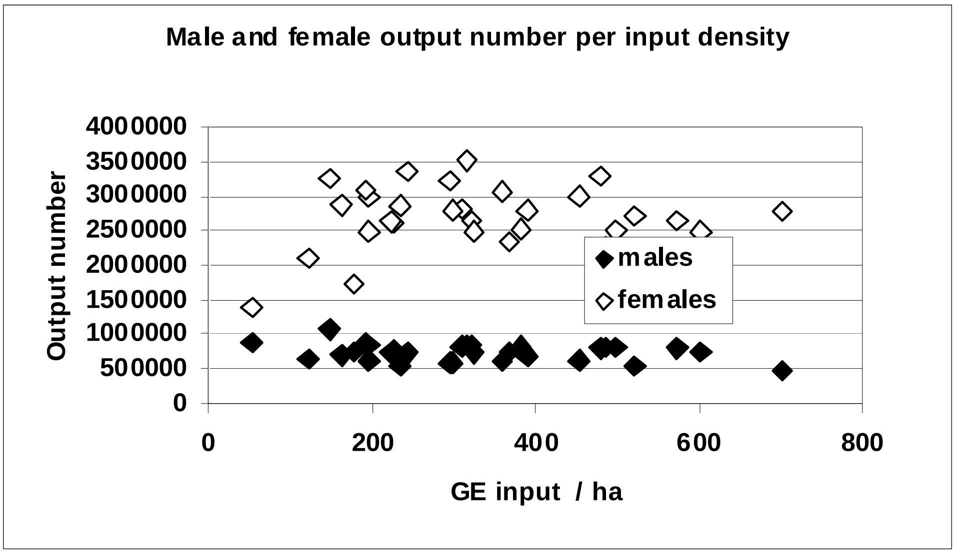


Figure 4.4: Lough Neagh Model output showing a output for input maximizing at input of 200 glass eel per hectare.

4.2.3 Density dependent processes in glass eel settlement

New analyses and modelling of Camargue Lagoon eel data.

Bevacqua *et al.*, 2009, in constructing models based on eel population data in Camargue lagoons, note density-dependent effects on glass eel settlement limiting initial settlement to around 1000 individuals/ha (Figure 4.5). This is approximately 5 times higher than the carrying capacity of Lough Neagh as noted by Rosell (presentation to WGEEL 2009) for trap-and transported upstream migrants and stocked elver, but relates to the first settlement of glass eel in a marine/estuarine type environment, whereas the Lough Neagh figure applies to eel in a later life stage after immigration to freshwater. The shape of the relationships however is similar, with a plateau reached at carrying capacity after which additional input has no significant benefit (approx. 1000 ind./ha).

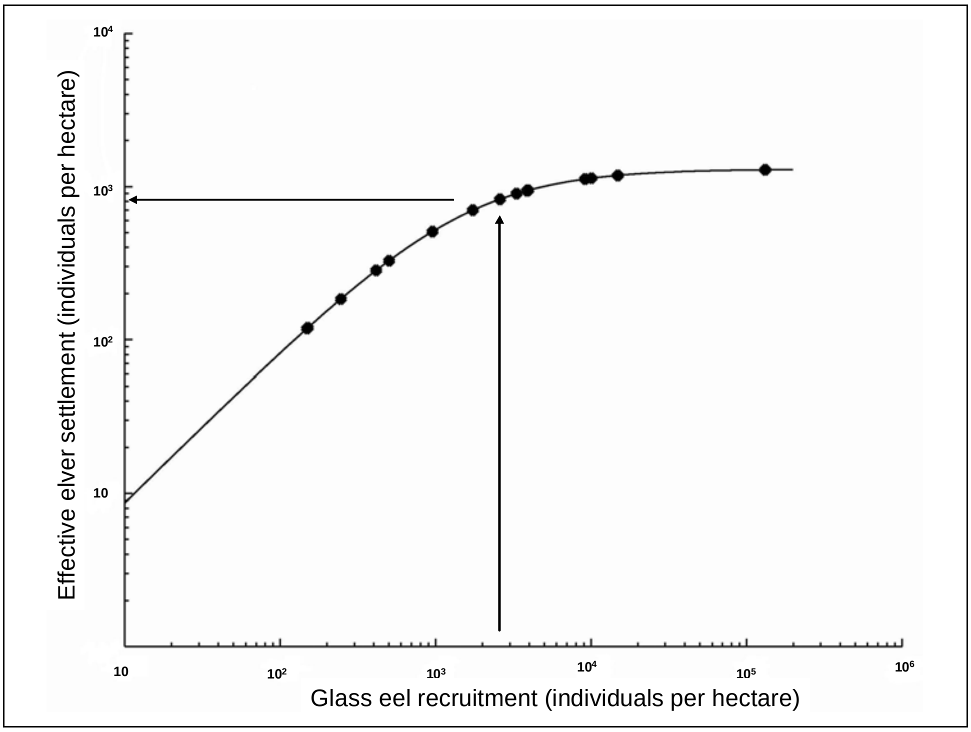


Figure 4.5: Modelled density-dependent relationship describing carrying capacity of Camargue lagoons for glass eel settlement, redrawn from Bevacqua *et al.*, 2009. Recruitment in individuals per hectare, settlement maximum 10^3 ind./ha.

4.2.4 The modelled effectiveness of glass eel stocking under intensive fishery pressure

(Psuty and Draganik, 2008)

The Vistula lagoon (Polish and Russian area totalling 83 800 ha) was stocked with glass eel from 1970 to 1994 with the aim of enhancing the stock for fishery purposes after a strong decline in the late 1960s. The number stocked differed from year to year with a mean of 4 million glass eel individuals/year. The effectiveness of the stocking was estimated with the simple method of calculating the accumulated biomass of fish from stocking with the assumed, constant coefficients F and M (fishery and natural mortality, respectively). This analysis was done for 17 age groups after introduction, based on age-readings from fishery catches where 99% of individuals were found to be from 5 to 16 years old. The estimated biomass of the eel population from stocking in the 1970–1994 period reached a peak in the mid 1980s (Figure 4.6). The peak of "exploitable biomass" (fish 5 years old and older) exceeded 1000 tons during the period 1982–1985. The catches resulting from the glass eel stocking component are estimated to have contributed some 400 tons/year. Much bigger exploitable biomass estimated during the 1980s did not influence catches because of effort limitation. The fishery demonstrated decreasing landing trends only after decreased number of stocked eels and the collapse of stocking in some years. Assuming stable mortality coefficients between the years of the analysis, results indicated the stock requirement to preserve the eel population and potential silver eel escapement, even under intensive fishery in the Vistula Lagoon. The basic requirement was to enhance the population each year at the mean level of 40 ind./ha.

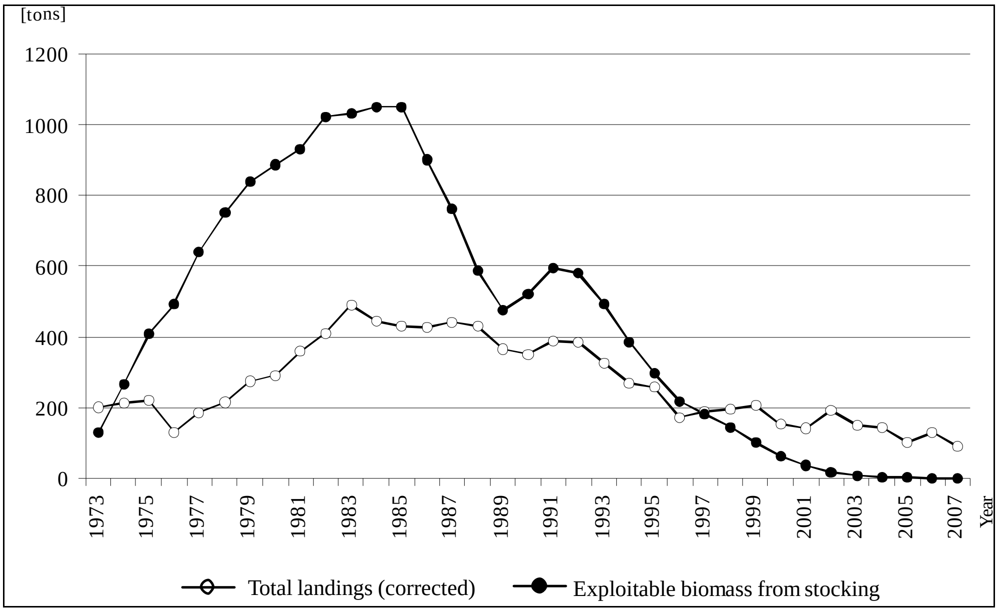


Figure 4.6: Estimates of biomass of caught and stocked eel in the Vistula Lagoon.

4.2.5 The structure of the commercial catches before and after stocking

(Psuty, 2009)

Until the late 1970s, the eel fishery in the Vistula Lagoon (brackish water, southern Baltic, the area of 83 800 ha) had been based on yellow eels and the fishery season had ended in September, which meant that most eel were landed in the spring–summer period. The first individuals from stocking were found in the catches after 3 years. Seven to eight years after the first stocking (started in 1970) the situation turned around completely, and the most important period became fall (September-October), with huge catches of migrating silver eels (distinguished by fishers on the base of the colour of the skin). Change was observed in the length and age frequency of fish caught. In comparison with the data from the 1956–1972, in the 10–15 years after first stocking the fishery catches were based on generally younger but bigger fish, implying that the stocked eel had better growth rate. However this change could be also connected with rapid eutrophication process during the late 1970s and 1980s. Direct sampling of unsorted catches during the period of 1954–1986, 1991–2001 and 2006–2007 confirmed that, in the length class under 27 cm TL, males were found at similar percentages of samples before and after stocking (Psuty, unpublished).

4.2.6 Comparing of stocked glass eels and farm eels after marking

(Unpublished data supplied to WGEEL 2009 by Janek Simon)

In a stocking experiment in Germany seven isolated lakes without drainage ditches were stocked with marked glass eels and farm sourced eels, and monitoring of stocked eels has been carried out every year to date. The initial total length and mass of the stocked glass eels and farm eels were 7.2 cm and 0.25 g and 14.6 cm and 6.3 g, respectively. First results demonstrate that mean recapture rate of eels stocked as glass eels increased with time from four to 41 eels per lake per year in the first three years after stocking. In contrast the mean recapture rate of eels stocked as farm eels were mainly constant with four to seven eels per lake per year in the first three years after stocking. The eels stocked as glass eels in the different lakes grew continuously a rate of 7.4 to 25.0 cm over the three years after stocking. In contrast eels stocked as farm eels grew discontinuously. In some lakes the mean increase in *TL* were very low whereas in other lakes farm eels increased their mean *TL* continuously. After three years of stocking, the mean *length increment* of eels stocked as farm eels were between 0.6 to 17.4 cm. Possible reasons for slow growth of eels stocked as farm eels in contrast to the faster growth of eels stocked as glass eels are that the farm eels need some time to return to natural food. This corresponds to the nearly constant Fulton's condition factor *K* and increasing intestines fat and gross energy of eels stocked as farm eels in the first two years after stocking. After three years, eels stocked as glass eel have reach the level of *K* and *gross energy* of farm eels. The farm sourced eels appear to live from fat reserves in the adaptation time. Over all lakes, the adaptation times were quickest when the present eel stock and food competition were low. For all lakes combined, three years after stocking, the recaptured eels stocked as glass eels and farm eels were estimated to be respectively 10.9% vs. 32.0% female, 1.5% vs. 4.0% male and 87.6% vs. 64.0% undifferentiated.

4.2.7 Stocking results in L. Võrtsjärv, Estonia

(Järvalt, A. Unpublished results made available to WGEEL, Kangur *et al.*, 2002)

Natural eel stocks have never been very dense in Estonian large lakes. The annual catch of eel in 1939 was only 3.8 tons from L. Võrtsjärv (270 km^2) and 9.2 tons from L. Peipsi (3555 km^2). The construction of the Narva hydropower station in the early 1950s blocked totally the natural upstream migration of young eel from the Baltic Sea to the basins of lakes Peipsi and Võrtsjärv. As a result, eel almost disappeared from the fish fauna of Estonian large lakes. Over 40 million glass eels were stocked into L. Võrtsjärv in 1956–2001. Since 2002 only farm eels (5g) were stocked. Recruitment to the fishable stock, resulting from the glass eel stocking component, starts at age 7 years and lasts up to16 years (>90% 8–12 year). The minimum legal size of eel was 60 cm and since 1998 it has been 55 cm. The average recapture was 6%, highest in 1970s 13% and lowest in 2000s at 4% (Table 4.1). According to results of anonymous questionnaires of fishermen and taking into account lack in registration of catches in different periods, the estimated recapture rate was 9.3%.

Table 4.1: Stocking of glass eels in 1956–2000, yield in 1964–2008 and re-capture percentage in L. Võrtsjärv.

Stocking rate				Yield		Recapture	
Stocking			Fishing	average 8-12 years later		Reported	Estimated
period	sp/ha	sp/ha/year	period	kg/ha	kg/ha/year	%	%
1956–1960	29	5.7	1964-1970	0.8	0.154	4.9	6.1
1961–1970	156	15.6	1971-1980	11	2.2	12.9	16.1
1971–1980	392	39.2	1981-1990	19.1	1.91	7	11.1
1981–1990	585	58.5	1991-2000	14	1.4	4.5	7.4
1991–2000	489	48.9	2001-2008	8.5	0.85	4.2	6
Total	1611			53.4			
Mean		33			1.3	6.7	9.3

4.2.8 Ongoing experiments for marking Swedish glass eel with Alizarin

The Swedish Board of Fisheries is conducting some full-scale experiments with marked stocked eels in some lakes in Sweden. The aims are to investigate survival rates, sex ratios, growth rates, recapture rates, etc. in stocked populations of eel. The overall goal is to find out if stocked eels eventually do support to the spawning stock and not only to a fishery.

In one experiment 5000 pigmented eels of about 1 g each were marked with Alizarin Complexone (ALC) and released at one site in the eastern part of the 400 km^2 Lake Mälaren close to Stockholm. This was done in 1997 and since then all eels caught in a yearly performed fykenet fishery were analysed with respect to fluorescence in their otoliths. During the last seven years marked eels have dominated the catch at this site and this year (2009) the recaptures constituted 60% of the total catch. The introduced eels have grown quite well and have now, after 12 years in the lake, reached about 65 cm corresponding to an overall growth rate of 47.5 mm/year and all are known to be female. Dispersal from the site has not yet been fully assessed. The accumulated recapture rate to date has reached 8% and will probably reach much higher values, indicating a high survival rate in this open system.

Similar experiments are in progress in other lakes where thousands of farmed (pre-grown) eels of different sizes were both marked and tagged with strontium chloride and PIT-tags, respectively. This makes a comparison between different sizes and year classes possible. However, these experiments are at an early stage and have so far revealed good growth rates but no difference between two successive cohorts/year classes or a difference in growth rates related to size at stocking.

The results from marking experiments like these have led to a demand for marking all eels used for stocking in Sweden. This will facilitate the subsequent evaluation of stocking as a stock enhancement measure (Wickström and Clevestam, 2009).

4.3 Tabulated data on known survival rates of stocked eel

Table 4.2 lists data on known survival rates of eel stocked into "wild" environments, compiled at WGEEL 2009. The data comes from experimental stocking in streams, lakes and saline water, summarized as follows:

Streams

Available surveys (Bisgaard and Pedersen, 1991 and Pedersen, 2009) suggest that stocking eels in small streams are of limited value as a consequence of low recapture rates. The surveys, however, are placed in the trout zone of the river basins and it is possible that the stocked eels migrate away from the stocking areas to lower parts of the streams where high water depth make monitoring difficult and are lost to the survey.

Lakes

Return rates in Swedish lakes (Wickstrom *et al*., 1996) stocked with young yellow eels during 14 years was 11.4% in a Mesotropic lake and 1,7% in an oligotrophic lake. In a small Eutrophic Danish lake survival rates were estimated to be 55–75 in wild and 42–57% 7–8 years after the lake was stocked. A high survival rate that may be explained by large yellow eels 20–40 gramme being used as stocking material in a newly established lake. The best known outcome of stocking in lakes is from "assisted migration" to Lough Neagh, Northern Ireland. (Rosell *et al*., 2005) Elvers captured downstream in traps are lifted into Lough Neagh. Return rates of yellow eel and silver eel in the fishery as presented to WGEEL 2009 are modelled at 10–60% of the number stocked, depending on input density. (Figure 4.2 above, ICES 2008a.)

Saline water

In saline water few studies are available. Anderson *et al*., 1991 stocked marked glass eel in a cooling water effluent at the Baltic coast. During their own sampling programme they recaptured between 1.3% and 3.5% but in various subsamples found between 30 and 50% recaptures. These data are comparable with Pedersen, 1998 who measured recapture rates from 0,1–10% at two different sites using three different stocking sizes (Table 4.1) Pedersen, unpublished, and described in Section 4.2.1.1 above) stocked saline Roskilde Fjord with 3 and 9 gramme and estimated return rates in the total fishery of 13% and 8% in the two groups respectively with an additional 5% silver of eel escapement.

4.4 Wild vs. farmed eels as stocking material

There is some evidence that farmed eels are not performing as well as wild eel. This may be related to different selectivity in wild and farmed condition. The eels stocked in a small Danish lake (Pedersen, 2000) demonstrated that the increase in biomass was three times as high in the wild batch when compared with the farmed batch. Stocking a stream, Bisgaard and Pedersen, 1991 found that the recapture rate was four times as high in wild eels compared with the stocked eel however the underlying causes are not clear and may be as a consequence of migration away from study area. In Lough Neagh, N. Ireland yield from non-local stocked glass eel to is between parity and one third of the value of local wild input (Section 4.3 above).

Table 4.2: Survival of eel measured actual data when stocked to wild.

Lifestage	Origin	Mean stocking size (g)	Stocking location	Salinity (ppt)	Productivity	Stocking rate (kg/ha)	Stocking rate (stk./ha)	Recapture rate (%)	Sex ratio (%)	Survival rate (%) per annum	Growth rate (cm/y)	Comments	Reference
Yellow, farm	FR, GB	12	Giber Å (river)	0	Eutrophic stream	36	3000	8		16.3	3.58	actual recapture rate after electrofishing	Bisgaard and Pedersen '91
yellow, wild	Giber Å, DK		Giber Å (river)	0	Eutrophic stream		400	33.6	Na	53.5	2.45	actual recapture rate after electrofishing	Bisgaard and Pedersen '91
Yellow, farm	FR, GB	3.4	Madum Å (river)	0	Eutrophic stream			14.5	Na	0.13	Na	actual recapture rate after electrofishing	Pedersen 2009
Yellow, farm	FR, GB	9,5	Madum Å (river)	0	Eutrophic stream			14.5	Na	0.16	Na	recapture rate is a estimated density in the river	Pedersen 2009
Yellow, farm	FR, GB	2.7 - 9.8	Tributaries to river Gudenå	0	Eutrophic stream			0-1	Na	<0.2	Na	recapture rate is a estimated density in the river	Pedersen 2009
Yellow, farm	FR, GB	11.2	Hjarbæk Fjord	0	Eutrophic saline	0.45	40	3.3	Na	-	5.3	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	26	Hjarbæk Fjord	0	Eutrophic saline	1.04	40	16.9	Na	-	3.5	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	52	Hjarbæk Fjord	0	Eutrophic saline	2.08	40	21.7	Na	-	2.5	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
glass eels	DK	0.3	Benedikte dam	0	Eutrophic	1.5	4948	11.5	Na	11.5	10.0-15.0	Recapture after emptying the dam 1 year after stocking	Dahl 1967
yellow	?			0	Oligotrophic Lake		25	5-10					Wickström 2001

Table 4.2. cont.

LIFESTAGE	ORIGIN	MEAN STOCKING SIZE (G)	STOCKING LOCATION	SALINITY (PPT)	PRODUCTIVITY	STOCKING RATE (KG/HA)	STOCKING RATE (STK./HA)	RECAPTURE RATE (%)	SEX RATIO (%)	SURVIVAL RATE (%) PER ANNUM	GROWTH RATE (CM/Y)	COMMENTS	REFERENCE
yellow	?			0	Eutrophic Lake		100	5-10					Wickström 2001
yellow	?			0	Oligotrophic Lake		5	40-80					Wickström 2001
yellow	?			0	Eutrophic Lake		20	40-80					Wickström 2001
yellow, wild	DK	19.2	Søndersø	0	Eutrophic Lake	3.321	173	55-75	0%	*55–75		*Population estimate made 8 years after stocking by tag recapture exp.	Pedersen 2000
Yellow, farm	FR, GB	39.2	Søndersø	0	Eutrophic Lake	11.76	300	42-57	0%	*42–57		*Population estimate made 7 years after stocking by tag recapture exp.	Pedersen 2000
Yellow, farm	FR	2.9	Fardume träsk	0	Mesotrophic Lake	0.452	156	3.2	Na		7-10	after 5 y	Wickström 1986
Yellow, farm	FR	4.0	Götemaren	0	Oligotrophic Lake	0.496	124	0	Na		Na	after 5 y	Wickström 1986
Yellow, farm	FR	2.9	Fardume träsk	0	Mesotrophic Lake	0.452	156	11.3	3 % male			Recapture during 14 years	Wickström 1996
Yellow, farm	FR	4.0	Götemaren	0	Oligotrophic Lake	0.496	124	1.7	31 % males			Recapture during 14 years	Wickström 1996
glass eels	Canada	0.2	Lake Morin	0	mesotrophic	0.2	100	0.5	30 % male		9.5		Verreault et al 2009
glass eels	SE	0.2	Oskarshamn	6–8	Swedish coast of Baltic Sea		in total 14.000	1.3	Na			Recaptures in their own sampling programme after several years 5–7?	Andersson *et al*. 1991

Table 4.2. cont.

LIFESTAGE	ORIGIN	MEAN STOCKING SIZE (G)	STOCKING LOCATION	SALINITY (PPT)	PRODUCTIVITY	STOCKING RATE (KG/HA)	STOCKING RATE (STK./HA)	RECAPTURE RATE (%)	SEX RATIO (%)	SURVIVAL RATE (%) PER ANNUM	GROWTH RATE (CM/Y)	COMMENTS	REFERENCE
glass eels	SE	0.2	Oskarshamn	6–8	Swedish coast of Baltic Sea		in total 6.800	3.5	Na			Recaptures in their own sampling programme after several years 5-7?	Andersson *et al*. 1991
Yellow, farm	FR, GB	11.5	South Fynen	12–14	Eutrophic saline	0.46	40	<0.1	Na	-	undetectable	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	25	South Fynen	12–14	Eutrophic saline	1.0	40	0.2	Na	-	6.5	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	65	South Fynen	12–14	Eutrophic saline	2.6	40	1.0	Na	-	4.3	Recaptures by fishermen during 2 years after stocking	Pedersen 1998
Yellow, farm	Fr	3	Roskilde fjord	12–18	Eutrophic saline		Na	13	35 % male	-	4-7.5	Recaptures by fishermen 7 -8 years after stocking	Pedersen unpublished
Yellow, farm	Fr	9	Roskilde fjord	12–18	Eutrophic saline		Na	8	35 % male	-	3-5.5	Recaptures by fishermen 7 -8 years after stocking	Pedersen unpublished
Yellow, farm	FR, GB	11.1	Isefjord	18	Eutrophic saline	0.44	40	0.2	Na	-	2.4	Recaptures by fishermen during 1 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	25	Isefjord	18	Eutrophic saline	1.0	40	0.9	Na	-	5.2	Recaptures by fishermen during 3 years after stocking	Pedersen 1998
Yellow, farm	FR, GB	58.4	Isefjord	18	Eutrophic saline	2.34	40	10.3	Na	-	Na	Recaptures by fishermen during 3 years after stocking	Pedersen 1998

4.5 Considerations on making the best use of a limited resource of glass eel

The continued severe decline in glass eel supply imposes major constraints on the possible extent of glass eel stocking. The latest compiled figures (See Data, Chapter 2 of this report) put the total European potential supply at less than 80 tonnes for the 2007–2008 cohort. While the data for the 2008–2009 cohort is not yet available for compilation, and will not be until WGEEL 2010, it is already clear that 2008–2009 will be the lowest glass eel catch on record and may be in the range of 35 to 40 tonnes maximum. In stark contrast to this, quantities of glass eel required to fully supply all former eel productive waters in Europe, as compiled in the Country Reports, are at least a factor of 10 higher than the current glass eel catch. Quantities of glass eel required over Europe as a whole are as high as 600 or more tonnes (Moriarty and Dekker, 1997). Many countries aspire to stock glass eel as part of their management plans, in line stocking being an option listed in the European regulation as a measure to help toward recovery of the stock and meet individual national or river basin targets. It cannot be stated too bluntly that potential demand for glass eel for stocking far exceeds the current supply.

It follows from this conclusion that all efforts should be made to prioritize stocking exercises and maximize output of potential spawners from the failing glass eel recruitment. Obvious recommendations are that:

Priority should be given to stocking in unpolluted waters with low pathogen burdens and no anthropogenic impacts.

Stocking should be at lower density to ensure high survival according to the water body being stocked. e.g. less than 200 glass eel equivalents per hectare, perhaps even less than 100 glass eel/ha.

Glass eels for stocking should only be sourced from rivers where a local surplus exists and the donor system is meeting its management plan targets.

Previous WG reports (e.g. ICES 2006, 2007, 2008a) have discussed the theory and concepts surrounding best use of glass eel in more detail, including ideas such as opting for a mix of stocking short-term high yield environments (e.g. Mediterranean lagoons) and long-term "banking" for future silver eel yield from the slower growing but high quality Scandinavian habitats).

4.6 The need for marking and suitable marking methods

Marking of eels to be stocked

As growth in eels differs at lot between individuals, the size in stocked eels from different cohorts will soon overlap making it difficult to distinguish between different cohorts of stocked eels as from natural eels by size only. To facilitate the evaluation of stocking programmes the use of marked eels has to be considered. Casselman, 2007 reviewed a number of marking techniques at a Workshop on the American Eel, *A. rostrata*, Stocking in Canadian Waters held in Montreal in 2007. He concluded that external tags often did not last long enough and may be difficult to use on small individuals, at least for mass marking. Examples of such external (or “physical”) methods are tattooing, latex marking as "visible implant elastomer" (VIE), PIT-tags and coded wire tags (CWT). The latter one has successfully been used in Denmark and Germany down to 1–3 g (Thomassen *et al.*, 2000, Simon and Dörner, 2005.). Internal methods as otolith marking using fluorochromes as Oxytetracycline (OTC) and Alizarin (Red or Complexone) or rare elements and isotopes like strontium (Sr) and barium (Ba) have been successfully employed in several studies (cf. Simon *et al.*, 2009).

Work in progress in Sweden uses $SrCl_2$ to introduce one of several rings of elevated strontium levels in marked otoliths. The marking is easily done by immersing the eels in Sr-enriched water for 24 hours, but the detection requires more sophisticated instruments like SEM or micro probes. Even though fluorochrome marked eels, or actually otoliths, are much more easily detected by using an UV-microscope, Sweden has decided to demand all eels stocked be marked with elements like strontium (Wickstrom, pers. comm.).

The use of antibiotics as OTC on a large scale may be deemed improper or even forbidden in some countries. If mass marking of stocked eels become a standard procedure, coordinated programmes between countries may be necessary, particularly in regions as the Baltic Sea drainage.

4.7 Glass eel quality

4.7.1 European Food Safety Authority (EFSA) Animal Health Animal Welfare Panel Report into the Welfare of European Eel in Aquaculture

The scientific report on the animal welfare aspects of husbandry systems for farmed European eel was published by EFSA in 2008. This was based on the findings of their Animal Health Animal Welfare (AHAW) panel into the variety of practices employed in the intensive aquaculture production of eel.

All husbandry practices were considered but of significance for WGEEL was the inclusion of the range of capture methods used throughout Europe to gather glass eel, given the fact that in the absence of a closed production cycle, farms require juvenile eel for seed stock.

EFSA highlighted that the existence of a human consumption market for (dead) glass eels did not favour good welfare practices in relation to glass eel capture as dead, and animals in poor condition, still had a high market value. This situation was seen as having a significant contribution into the use of glass eel fishing practices where fishing mortality rates could be as high as 50% (EFSA, 2008). Given that capture method is critical to the health and productivity of eels used in aquaculture and restocking it was concluded by EFSA that current glass eel fishing practices produced a high level of stress and trauma which resulted in subsequent high levels of mortality, both acutely and over the following 20 days. Their recommendations were to amend current capture practices to reduce their impact or to use known capture methods already identified as having fewer, less severe hazards associated with them.

4.7.2 Glass eel capture methods for supply of stocking material

Selecting the best fishing gear

A report on eel welfare prepared for the European Food Safety Agency (EFSA, 2008), has identified that some capture methods for glass eels (active trawling and fixed nets) present the following hazards to the welfare of eel:

- skin damage incurred at capture - osmo-regulatory failure within 7–10 days;
- tail damage incurred at capture - damage to the caudal sinus, secondary infections;
- stress, loss of mucus during storage (post capture);
- stress, skin damage, loss of mucus during handling (post capture).

These hazards were given high scores in the EFSA group risk assessment because they occur frequently (if not invariably), affect a large proportion of the populations and have severe impact on glass eel. Inappropriate handling post capture has the highest score because the duration of the effect (skin damage and loss of mucus) lasts up to 20 days (when all affected individuals would eventually die). The damage caused to the tail results in a very high degree of mortality and is only noticed 48 hours after capture. It was also noted that trawling results in high mortality within the first hour after capture. Mortality that occurs at capture (mainly as a consequence of crushing) can be also be considerable (order of magnitude around 50% within a few hours following capture). Poor storage leads to exposure to air, adverse water quality, and confinement leading to loss of mucus and stress.

Figure 4.7: Tail tissue damage to glass eel demonstrated by Rose Bengal staining (Photograph courtesy of UK Glass eel).

Briand *et al.*, 2009, reporting on post fishing mortalities of glass eels monitored in 2007 in the Vilaine estuary, identified mortality of glass eel varying from 2 to 82% (mean 42%) in the two days following the pushnet fishery. The mortality of samples collected by handnets or from the trapping ladder was nil. Alterations of skin mucus were analysed by the used of indigo carmin. Mortality was significantly correlated with body injuries, but not to other environmental factors. The presence of a large injury on the body always led to the death of glass eel, and among dead glass eels, only 3.5 % might have died of factors outside fishing conditions.

These new reports expand on the note by WGEEL 2008 that glass eel caught using moving and stationary fishing gears may be subject to handling mortality. (e.g. in trawls may this be up to 40%) and that reduction of these mortalities would lead to more efficient use of the limited and declining resource of glass eels. With the severe decline in the resource and a shift in emphasis in use of glass eel toward restocking under the EU regulation, research into making glass eel capture methods as fish friendly as possible would clearly be advisable - hand netting or similar methods are generally considered likely to present better options than trawling or driven nets. Given the noting of tail damage (Glass eel will often try to reverse through net meshes of holding containers), varying or reducing the mesh sizes used in some gears would also be worthy of investigation. Figure 4.7 demonstrates the type of often unseen tissue damage possible to glass eel held in inappropriate meshes.

In the ICES review of the Netherlands EMP[1], the ICES reviewers state (ICES 2008b) that "if the aim is to use restocking to achieve the target and be independent of natu-

---

[1] http://www.minlnv.nl/cdlpub/servlet/CDLServlet?p_file_id=41962

ral recruitment, restocking could be increased to about 40 times the planned restocking, i.e. 40–64 tonnes of glass eel (0.3 g). Taking into account the mortality in the process of catch and transport, this corresponds to a catch of glass eel of 80–130 tonnes". The reviewers have used a working assumption of 50% mortality between glass eel catch and material successfully stocked, i.e. assuming material captured by active mobile methods.

4.8 Conclusions and recommendations for Chapter 4: Advances in stocking

There is clearly insufficient quantitative data from targeted studies of the performance of stocked eel in open wild environments, and more would help considerably in formulating advice on if, when, where and how much to stock. The studies reviewed by WGEEL demonstrate that the performance of stocked material in the yellow eel phase cannot be assumed to be as good as that of natural immigrants, but also conversely that it often falls within the ranges of best and worst observations of performance of wild stock. The few direct comparisons of stocked vs. wild eel growth and survival put the range of relative performance of stocked to wild at between 25% and parity. It is reasonable to assume that the degree of handling and intervention between glass eel and stocking strongly influences the outcome, and that best stocking practice is that which mirrors the local wild component.

There is a lack of information on the outcome of previous stocking exercises in terms survival of stocked material through to eventual escapement of silver eels.

WGEEL 2009 therefore recommends that all stocking activity from now on be designed to include traceability of eel into later life stages. The best means of ensuring conclusive traceability is by using batch or other marking methods. OTC alizarin and strontium have all been used successfully to date on glass eel, PIT, CDTs, and other tags for larger stages.

In order to address the total absence of data on potential ocean migration of silver eel derived from stocking, future tracking studies, similar to and successors of EELIAD should include the ocean tracking of silver eel known to have been derived from stocked material.

Given the current low and declining availability of glass eel for stocking, and the stipulation in the eel regulation for an increasing proportion of glass eel to be made available for stocking, it is essential to optimize the quality and survival of the glass eel destined for stocking. Stocking should be optimized to support the spawning stock.

A best practice manual on capture, storage and transport of glass eel is urgently required.

5 Eel quality

Chapter 5 updates the European Eel Quality Database (EEQD) and discusses the importance of the inclusion of spawner quality parameters in stock management advice (ToR e and f):

e) establish international databases on eel stock, fisheries and other anthropogenic impacts, as well as habitat and eel quality related data, and the review and development of recommendations on inclusion of data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, on stock assessment methods;

f) review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these in stock assessment methods.

5.1 Introduction

In recent years (e.g. ICES 2006, 2007 and 2008a) the Working Group has discussed the risks of reduced biological quality of (silver) eels. The reduction of the fitness of potential spawners, as a consequence of (specific) contaminants and diseases and the mobilization of high loads of reprotoxic chemicals during migration have been demonstrated to decrease the probability of successful migration and normal reproduction. Hence, eel quality is believed to be an important issue in understanding the reasons of the decline of the species.

In the recommendations of the WGEEL 2006, it was suggested that the term 'quality of spawners' should be included in the stock management advice, describing "the capacity of silver eels to reach spawning areas and to produce viable offspring" (ICES, 2006). Quantifying the impact of pollution and parasitism has therefore been a focus of a WG subgroup in recent years. Therefore WG reports have presented an overview and summaries of a variety of reports and data on eel quality. Hence, this chapter should be read in conjunction with the 'eel quality' chapters in ICES 2006, 2007 and2008a.

The recommendations of WGEEL (ICES 2008) on the eel quality issues focused on the need for the continuation on a local scale of the long-term monitoring of quality (contaminants, parasites and disease) in eel with an emphasis on standardizing the methodological approach, analysis of new compounds, an appropriate communication system and robust data management. It was recommended that the European Eel Quality Database should be developed and maintained, and that Member States should initiate harmonized monitoring strategies aimed toward the development of a European Eel Quality Monitoring Network, to collect the relevant data to be fed into the EEQD. Another recommendation addressed the need to investigate the eel quality of the eels leaving continental waters so as to include quality aspects in eel stock management and evaluation of effective spawning escapement. Some progress has been made by some MS who initiated studies on contamination, fitness and diseases, and a FP7 joint research programme has been initiated aiming at collecting quality data of escaping silver eels in European catchments (Eeliad www.eeliad.com).

5.2 The European Eel Quality Database (EEQD)

5.2.1 Introduction

In 2006, the EEL WG recommended that further sampling and ongoing monitoring into eel quality was urgently required. Member countries should set up a national programme on RBD scale to evaluate the quality of emigrating spawners. This should include body burdens of toxic compounds but also infestation levels with parasites and virus. It should be included in the national management plans although special emphasis should be given to standardization and harmonization of results (units and methods).

WGEEL 2008 recommended the development of standardized methodological approaches for the evaluation of eel quality. A protocol to assess eel quality has been kindly provided by the EU Eeliad research project ("Guidance for field measurements to assess silver quality") and has been made available on the ICES Sharepoint. Another protocol has been published from the Indicang project (Adam *et al.*, 2008).

The European Eel Quality Database was created in 2007 and updated in 2008 (see ICES 2008a for details). The database integrates data of contaminants (polychlorine biphenyls, pesticides, heavy metals, brominated flame retardants, dioxins, PFOS), diseases and parasites (such as *Anguillicoloides crassus*, bacteria, and viruses such as EVEX and other lesions), and fat content.

Before and during the 2009 meeting the EEQD was updated with new data. These data were retrieved from recently published reports or scientific papers. Furthermore some MS provided new data for inclusion in the EEQD. Some of these data are derived from work in progress.

5.2.2 Parasites and diseases

The following countries provided new information on parasites and diseases for inclusion in the EEQD.

Denmark stated that *Anguillicoloides crassus* is widely distributed in freshwater and brackish water all over the country. Data on prevalence and intensity of infection given for three sites remained stable in 2008 when compared with former years. France mentioned an extensive report on parasites and pathogens by Elie and Girard, 2009 of which the most important findings are summarized in Section 5.4.1.

In Ireland 75% of the potential eel production is now potentially affected by *Anguillicoloides crassus* (73% of the wetted area). Prevalence in infected sites is ranging between 54% and 88% whereas infection intensity is between 3.4 and 6.3. Out of seven lakes and rivers investigated in 2008, only eels from the small Burrishoole catchment were not infected by the parasite.

From market sampling in Lake Ijsselmeer, the Netherlands, the percentage of infected eels and the parasite burden demonstrated a slight decrease in recent years. In 2008 the percentage by naked eye inspection was 40% compared with about 60% in 2005.

In Norway, the presence of *Anguillicoloides* was first recorded in 1993 in an aquaculture facility. Probably as a consequence of a lack of a routine monitoring programme, the presence of the parasite in the wild was only confirmed in Southern Norway in 2008 (in River Enningdalselva, River Drammenselva and in the River Imsa, Mo 2009). 80% of 70 inspected eels from R. Imsa were infected (Bergesen, 2009).

In the marine coastal areas of Sweden prevalence of *Anguillicoloides crassus* was 15% in most marine areas but increased to more than 40% in Öresund and to 55–61% in Baltic sites (data from 2002–2008). Infestation of eel sampled mainly from freshwater was 49% in 2008 and 65% in 2009, respectively. Data collection on the infection with *A. crassus* in three Swedish lakes started as early as 1992 (Lake Fardum) and 2002 and 2003 for Lake Malären and Lake Ymsen, respectively. The infection of eel with the parasite was first observed in 1996 in Lake Fardum but with a very low prevalence of 9%. Prevalence in this Lake raised to 89% in 1999 and ranged between 2003 and 2008 between 64 and 76%. In Lake Malären, the prevalence increased from 76% in 2002 to 83% in 2004. The proportion of infected eels slightly decreased in most recent years and was ranging from 65% in 2008 to 61% in 2009. Eels from Lake Ymsen demonstrated consistently high prevalence in most years from 2003 to 2009 reaching up to 92 % in 2009.

Although there is no routine sampling or monitoring of parasites or pathogens in England and Wales, *Anguillicoloides crassus* is thought to be ubiquitous now. In Northern Ireland the parasite was first found in 1998 in the Erne catchment. In Lough Neagh *A. crassus* was first found in 2003. In 2008 the prevalence was 67% in yellow eels and 86% in silver eels, respectively. In Scotland, there is to date only a single reported instance of *A. crassus* (Lyndon and Pieters, 2005) but the absence of targeted effort on the identification of *A. crassus* may have led to under-recording. However, the likelihood is that *A. crassus* is not sufficiently widespread as yet in Scotland, as a consequence of low levels of stock transfer.

In Portugal, a study conducted during 2008 (unpublished data) in 5 brackish water systems (Aveiro Lagoon, Óbidos Lagoon, Tagus estuary, Santo André Lagoon and Mira estuary) demonstrated that *A. crassus* is present in all, except in Óbidos lagoon, which is probably related to the higher salinity observed in this lagoon, similarly to what happens in one sampling site (Barreiro) (Neto *et al.*, in press *a*) located in the lower part of the Tagus estuary. Prevalence ranged from 0 to 100%, whereas intensity varied between 0.4 and 5.8. The presence of this nematode had already been reported for River Minho (Antunes, 1999) and River Mondego (Domingos, 2003), which suggests the parasite is probably widespread in Portugal.

5.2.3 Contaminants

Following countries provided new information on contamination by chemical compounds for inclusion in the EEQD.

For Belgium unpublished data of a recent study (Roosens *et al.*, in prep) is reported where pooled eel samples from 50 locations in Flemish waters collected in the period 2000–2006 were used to assess the degree of pollution with the brominated flame retardants PBDEs and HBCDs. Concentrations of sumPBDE ranged between 10 and 5811 ng/g lipid weight (lw). SumHBCDs ranged between 16 and 4397 ng/g lw, with a median value of 73 ng/g lw. Comparison with previous studies demonstrates that PBDE and HBCD levels in Flemish eels have decreased rapidly between 2000 and 2008 at some particular sites, but also that alarming concentrations can still be found at industrialized hot spots. Human intakes of eel by fishermen were above reference doses described in literature to induce adverse effects.

A programme of PCB analysis in eel (among 5 other fish species) was set up by the French Ministry of Agriculture in order to prioritize sectors of intervention to reduce risk for human food but results of the first set of analyses are not yet available.

The country report of the Netherlands cites two reviews one with data of spatial distribution of PCB in eel (Hoek-van Nieuwenhuizen and Kotterman, 2007) and another with data on a temporal trend of PCB in eels sampled in the Netherlands (Hoogenboom *et al.*, 2007). The highest concentration of PCB could be measured in the southern part of the Netherlands (Meuse and Rhine delta) whereas lower concentration is observed in the Ijsselmeer region. In general the PCB concentration (ex. PCB 153) demonstrates a downward trend in eels at least for the last 20 years.

In the Netherlands, in Lake Ijsselmeer, market sampling of both yellow and silver eel is conducted since 1960. Since today more than 108 000 yellow and 11 900 silver eels have been sampled and inter alias length and weights have been recorded. This long-term time-series has been investigated for temporal changes of the Fulton condition factor k (Nash *et al.*, 2006; Ricker 1975). The results have been corrected for changes in length composition of the samples, variation between month, and differences between gear and mesh sizes. For the time period from 1960 to 1980 a slight decrease could be demonstrated. However, from 1980 until today an increase of 9.4% for yellow eel and 11.3% for silver eel, respectively, was estimated. A comparison with the observed upward trend in water temperature could be indicative of causal relationship which needs further investigation before final conclusion. This finding contrasts with the analysis of Belpaire *et al.*, 2008 on a downward trend in fat content and condition factor (Le Cren) in Dutch eel samples from the 1980 until present. The question remains whether condition factor of eels in Lake Ijsselmeer and fat content could have developed in opposite directions and further analysis will be required.

For England and Wales new data are provided in the country report of UK Samples from 35 eels caught in autumn of 2007 in the River Thames between Sunbury and Molesey (upstream of the tidal limit) and in the Thames estuary around Woolwich were analysed for 14 organochlorine pesticides and by-products and 41 PCB congeners, including the seven frequently detected congeners commonly used as indicators for PCB contamination (Jurgens, Johnson, Chaemfa, Jones and Hughes, 2009). Most of the investigated chemicals were detectable in every one of the samples although they have all been banned or severely restricted many years ago. However, based on the measured chemicals, all the analysed eels would still be considered safe to use for human consumption. ICES7 PCB contamination levels were fairly typical for recent UK eel data but lower than a few of the UK eel samples from the 1990s, whereas DDE and lindane contamination was lower than in the very few other UK eel studies that reported these chemicals. Compared with a recent European survey, the PCB contamination found in the eels is this study was approximately in the lower third of values. For Northern Ireland and Scotland no new data are available compared with former years.

For Portugal, new data (Neto *et al.*, submitted *b*) is provided in the country report. Samples of eels caught from five brackish water systems (Aveiro Lagoon, Óbidos Lagoon, Tagus estuary, Santo André Lagoon and Mira estuary), were analysed for some trace metals (Hg, PB, Zn, Cu, Cd) revealing low contamination loads when compared with their European congeners. The most contaminated eels were obtained from the Tagus estuary.

5.3 Management of the European Eel Quality Database

These data were included in the EEQD and the database was made available on the ICES SharePoint to members of the WG Eel. The management of the WGEEL eel quality database will require more effective and timely inputs of data from participating countries in future and some helpful discussion of some of the issues involved was possible at the 2009 meeting. However, because it was recognized that there might be difficulties at national, agency or individual level, in respect of intellectual property rights or concerns that open circulation (e.g. to non-working group authors or other funded projects) of some results it is recommended that direct contact be made to data-providers (via national WGEEL representatives/national database managers) prior to publication. However, the inclusion of data should not limit management decisions and implementation of eel management plans or the periodic EMP reviews required by EU and member states. In many cases, data-inputs will relate to EU or other publicly funded research programmes in which commitments to public data access are an essential feature of the research or monitoring process and therefore such problems are less likely to occur. However, even in these cases, time-lags in data inputs or temporary limitations in access may arise and necessitate direct contact with data-providers. The protocols adopted for database management should reflect a pragmatic approach to such problems and development of a strategy for data-collation that extends beyond the annual country report summaries and allied inputs to the database. Long-term management of the eel quality database are also a complicating factor, as no one individual or state agency can commit necessary skills or resources on an open time frame basis. A possible solution would be for the eel quality database to be managed at an international level (e.g. by ICES or some European agency, with long-term funding options and database management expertise). Though currently given lesser priority in respect of the EU eel recovery plan than estimation of spawner escapement and associated eel conservation measures, it can be reasonably anticipated that quality issues will increasingly assume a greater importance in eel management plans. Therefore, appropriate research should be encouraged. Also, development of effective specialist researcher networks and support for workshops or publications that can speed up inputs to national databases and the eel quality database should be promoted. A particular focus of the eel quality database should be the periodic reviews of EMPs required by EU and special efforts should be made to encourage data-providers to input available data well in advance of EMP review deadlines. Effective data management, and recognition of the constraints that have resulted in delayed or incomplete inputs in the past, is considered to be most likely to ensure that management decisions are as well informed as possible.

Although new information has been provided on eel quality in several countries, the WG Eel noticed that a comprehensive overview on the eel quality over its distribution area is far from complete and urges MS to measure eel quality in their river basins and make them available to the EEQD.

5.4 Quantifying the effects of eel quality on stock dynamics and integrating these in stock assessment methods?

5.4.1 Introduction

As a consequence of the international concern about the stock decline many studies have recently been undertaken to study the degree and the effects of pollution on the eel, resulting in an increasing quantity of information that demonstrates the negative impact of pollution on eel. Two recent reviews have described the effects of contaminants on the eel (Geeraerts *et al.*, accepted and Elie and Gerard, 2009).

The review by Geeraerts and Belpaire gives an overview of the literature on the effects of contaminants on the European eel and on the consequences on the biology and fitness of the eel in order to document the role of pollution in its decline. The authors provide an overview of lethal toxicology studies from the primary scientific literature on the European eel *Anguilla anguilla*. A variety of contaminants have been found to affect the eel. Information (and toxic doses) is presented for 38 chemical compounds. In another table an overview is presented of studies on the effect of contaminants on target organs in the European eel (ca 30 papers). Exposed concentration, experimental conditions and effects are indicated. Contaminants may cause disturbance of the immune system, the reproduction system, the nervous system and the endocrine system and effects were reported on several levels of biological organization, from subcellular, organ, individual up to even population level.

Also in the technical report from Elie and Girard, 2009 knowledge of the effect of contaminants and pathogens on the European eel, *Anguilla anguilla* is reviewed. For the full references given here in Section 5.4.1 we refer you to Elie and Girard, 2009. Infection by pathogens and exposition to contaminants are among the potential causes and the European eel has been found to be very susceptible to these threats as compared with other species (Bruslé, 1990; 1994). Indeed, its high lipid content, its long growing phase, its opportunistic feeding regime, its pelagic and benthic life style and its top position in the foodweb makes it a species exposed to different types of pathogens and contaminants, and susceptible to bioaccumulation (Pasquaud *et al.*, 2008). Multiple studies have revealed that the European eel represent one of the fish species accumulating the highest quantity of contaminants such as PCBs (Newsome and Andrews, 1993; Miao *et al.*, 2000; Ashley *et al.*, 2003; Bordajandi *et al.*, 2003; Tapie *et al.*, 2006), polycyclic hydrocarbons (Pointet and Millet, 2000; Roche *et al.*, 2002), pesticides (Bordajandi *et al.*, 2003; Hoff *et al.*, 2005) and heavy metals (Barak and Mason, 1990; Collings *et al.*, 1996; Linde *et al.*, 1999; Perez Cid *et al.*, 2001, Usero *et al.*, 2003, Durieu *et al.*, 2006; Pierron *et al.*, 2007; 2008). Different levels of contaminants have been found according to eel length and age, supporting the bioaccumulation hypothesis for PCB (Tapie *et al.*, 2006), organochlorines (Bruslé, 1994) and cadmium (Pierron *et al.*, 2007; 2008) for example, with some evidence of major impacts on spawning (Pierron *et al.*, 2008) and spawning migration (Van Ginneken, 2009). In a context of long-term bioaccumulation, high concentration of contaminants might not be related directly to the sampling site where eels were captured (Ramade, 1989; Tapie *et al.*, 2006; 2009). At the present time, very few ecotoxicological studies have evaluated the influence of contaminants at different life stages in eels and the potential influence on spawner quality. Among the few, Palstra *et al.*, 2006 have reported transfer of PCBs from female silver eels to gonads as well as a correlation between increased PCB levels in females and reduced survival time in embryos, with levels over 4 ng TEQ/kg gonads being associated with no embryo survival. Pierron *et al.*, 2008 also found a negative effect of cadmium on sexual maturation of female silver eels and suggested a negative effect on silver eel migration by altering the lipid accumulation process. Finally, Van Ginneken *et al.*, 2009 also demonstrated that transoceanic spawning migration is altered by PCBs. Contaminants could then represent important factors related to the decline of eel.

The toxic effects can occur at different moments in eel's life cycle: during growing, silvering, migration, the development of reproductive cells, and larval stage. Most reports deal with the yellow eel stage and a wide range of effects have been demonstrated. However, in the yellow eel phase, the effects are apparently less harmful, because contaminants are stored in lipid tissue while growing. It is assumed that most toxic effects start to develop during the silvering phase, when morphological and physiological changes take place initiated by hormonal changes. Meanwhile, fat is being metabolized, resulting in a remobilization of the live-long accumulated contaminants. Silver eels migrating to the Sargasso Sea, stop feeding and live on their fat stores. Thus, the energy stores must be sufficient to cover the 6000 km long journey and to produce enough good quality eggs. Recent observations of decreasing fat stores in yellow eel questioned the ability for eels to succeed in fulfilling this migration and spawning (Belpaire *et al.*, 2009). Some chemicals such as PCBs and Cd have been demonstrated to disturb the fat metabolism. A continuous fat burning during migration means an increasing continuous availability of contaminants and a high level of toxicity in the eel. This toxicity causes disturbance of the immune system, the reproduction system, the nervous system and the endocrine system. Both, the reduction of the lipid energy as a consequence of (specific) contaminants, and the mobilization of high loads of reprotoxic chemicals during migration, seem to be key elements decreasing the probability of a successful migration and normal reproduction. Hence, contaminants are believed to be an important issue in understanding the reasons of the decline of the species (Geeraerts and Belpaire, accepted).

The review by Elie and Gerard, 2009 has also described the effects of diseases on the eel stock (see Elie and Gerard, 2009 for the full references). Diseases might certainly play a role in the decline of the species as suggested by Elie, 1997. Human activities are related to the introduction of new pathogens affecting the European eel, such as during inter-regional and inter-continental eel transfers, as demonstrated by *Anguillicoloides crassus* introduction in multiple countries in Europe from South-East Asia. Observed eel parasites include three main pathogen classes: 1) viruses, such as the herpes virus (Davidseu *et al.*, 1999), the rhabdovirus EVEX (Wolf, 1988), the European virus EVE (Wolf, 1988) and a reovirus (Haenen *et al.*, 2001); 2) bacteria, such as *Aeromonas* spp. (Aoki, 1999), the European introduced *Yersinia ruckeri* from the USA, *Vibriosis* spp causing septicemia and *Pseudomonas* spp. causing ulcers, and 3) parasites and fungus such as protozoans infecting skin and internal organs, myxozoans forming kysts and different species of worms infecting internal organs, such as the nematode *Anguillicoloides crassus* infecting swimbladders. *A. crassus* was introduced in Europe at the beginning of the 1980s from Japan and can cause a degradation of the bladder functions and affect swimming capacities (Lefebvre *et al.*, 2004 a and b). Laboratory experiments have revealed that *A. crassus* can cause high mortality rates (Molnar *et al.*, 1994) and affect gene expressions related to environmental stresses and osmoregulation (Fazio, 2007; 2008 a, b, c, d). However, more research is needed to understand the global impact of this parasite and other pathogens on eel reproduction and abundance. Even less studies have looked at the interactive effect of contaminants and parasites on eel reproduction and survival. One of the very few studies looking at the combined effect of *A. crassus*, cadmium (Cd) and PCB suggests that pathogen effects on eels are exacerbated by contaminants, which might have important negative consequences on individual survival (Sures *et al.*, 2006).

5.4.2 Effects of certain chemicals such as PCBs and DDT on the stock

Eels are more vulnerable than other fish as they accumulate contaminants to a much higher degree than other species. In many fish species in Western Europe, pollution has been reported to hamper normal reproduction and larval development (endocrine disruption). For example, a study by Hugla and Thomé, 1999 demonstrated that PCBs, even at environmental levels, clearly affect various physiological and biochemical parameters in the common barbel *Barbus barbus* and reduce the fecundity and hatching rate of the species. Yet undeniably, the chronic effects of PCBs have played and still play a role in the regression of some barbel populations in polluted areas, as DDT did for birds in the 1960s (Hugla and Thomé, 1999). Considering the high levels of contamination in eels for many areas, endocrine disruption in mature silver eels can be expected, jeopardizing normal reproduction (Belpaire, 2008). Many contaminants are widespread and measured concentrations in eel are at a level which more than likely is causing ecotoxicological effects in eel. An extensive dataset of contaminants has been analysed by statistical modelling, to demonstrate relationships between fitness (lipid content and eel condition) and various environmental variables. It was concluded that PCBs (especially the higher chlorinated ones) and DDTs have a negative impact on lipid content of the eel. (Geeraerts *et al.*, 2007).

Currently, threshold values for the negative effects of chemicals such as PCBs and DDT on stock level are difficult to obtain as a consequence of the complex life cycle of the eel which hampers studies of the toxic effects of individual chemicals on the reproduction of the eel.

As already mentioned, Palstra *et al.*, 2006 observed a negative correlation between embryo survival time and TEQ (toxic equivalent) levels in the gonads implying TEQ-induced teratogenic effects. The disrupting effects occurred at levels below 4 pg

TEQ/g wet weight gonad, which is below the EU maximum consumption limit for dioxin in food (Palstra *et al*., 2006).

Embryonic malformations are typical for PCB-exposed eggs and indicate negative interference with dioxin-like contaminants (Helder, 1980; Walker and Peterson, 1991; Walker *et al*., 1994; Stouthart *et al*., 1998) in other species. Monitoring studies (van Leeuwen *et al*., 2002) demonstrate that most silver eels from Holland have TEQ values above the threshold levels suggested by Palstra *et al*., 2006. So, matured eels with values >1 ng TEQ/kg gonad may not participate in successful production of vital offspring. A difficulty remains to extrapolate this threshold value to reference values for eels that have not matured yet and per kg muscle. However, fats including accumulated PCBs that were originally in the muscle have been incorporated in the oocytes of the mature female. Under this assumption we can extrapolate the found values to ng TEQ/kg muscle in wild silver eels.

As pollution effects of other fish species have been better studied it might be relevant to obtain threshold values for PCB for normal reproduction in other fish species. Kime, 1995 reviewed the effects of contaminants in fish. More recently, Lawrence and Hemingway, 2003 described the molecular effects and population responses of pollution in fish, and Monosson, 2000 presented a synthesis of laboratory and field studies related to the reproductive and developmental effects of PCBs in fish. From these reviews it is clear that in many fish species reproduction is inhibited by several contaminants at environmental concentrations. Several papers were reporting correlations between ovarian concentrations of chemicals and hatching success (i.e. for PCBs in minnows, starry flounder, flounder, herring and whiting, for DDE in herring and whiting; for dieldrin in cod).

In a recent paper von Westernhagen *et al*., 2006 compared tissue burden and hatching success in whiting. The data presented in this paper indicate that chlorinated hydrocarbons accumulated in ovaries of North Sea whiting exert significant negative effects on embryonic development and production of normal larvae at relatively low tissue concentrations. For the major contaminants SUMDDT (sum of p,p′ DDT, p,p′ DDD, p,p′ DDE), dieldrin and SUMPCB (being the sum of CB 118/149, 153, 138, 180) threshold values higher than 20, 10 and 200 μg kg^{-1} wet wt. respectively impeded reproduction considerably (viable hatch below 10%). Threshold values of ovary contamination above which impairment of reproductive success was likely to occur, were given.

>200 μg kg^{-1} wet wt. for SUMPCB

>20 μg kg^{-1} wet wt. for SUMDDT

>10 μg kg^{-1} wet wt. for dieldrin.

In the absence of clear relationships between body burden in muscular and ovarian eel tissue, we used the field concentrations measured in eel muscles and compared that with the ovarian threshold concentration in whiting. We are aware that this is not strictly comparable and may only be treated as indicative and these comparisons treated with caution. Threshold and impact levels in eel may be very different from those in whiting. In fish, studies of gonad to muscle ratios of PCBs indicate at least five times greater concentrations in eggs compared with muscle.

These threshold values for PCBs, DDTs and dieldrin were compared with eel contaminant data from the INBO Flemish Eel Pollutant Network (Belgium) (2463 eels collected in the period 1994–2005):

- 1219 out of 2461 yellow eels (= 50%) had Sum PCB (CB 118, 153, 138, 180) concentration in their muscle >200 ng/g.

- 2146 out of 2463 yellow eels (= 87%) had Sum DDT concentration in their muscle >20 ng/g.
- 907 out of 2463 yellow eels (= 37%) had dieldrin concentration in their muscle >10 ng/g.

From a study (Hoogenboom *et al*., 2007) in The Netherlands (62 yellow eels from 22 sites) (51 out of 62 yellow eels (=82%) had Sum PCB (CB 118, 153, 138, 180) concentration in their muscle >200 ng/g (Figure 5.1).

In a recent study (Jürgens *et al*., 2009), eels from the Thames were analysed (35 eels from two sites) and mean concentration of total DDT and for Sum ICES 7 PCB was 17.4 ng/g body weight and 48.7 ng/g body weight respectively. In this study, PCBs and DDTs were thus lower than the threshold values for most of the eels.

We compared these threshold values with the data of contaminants measured in eel from several European rivers/lakes. Figures 5.2–5.4 have been generated from data from the EEQD. From the data and figures presented it is clear that, overall, the body burden of PCBs, DDTs and dieldrin in eels over Europe is so high that in many eels we may expect negative effect on normal reproduction, although large variations between catchments or countries are noticeable.

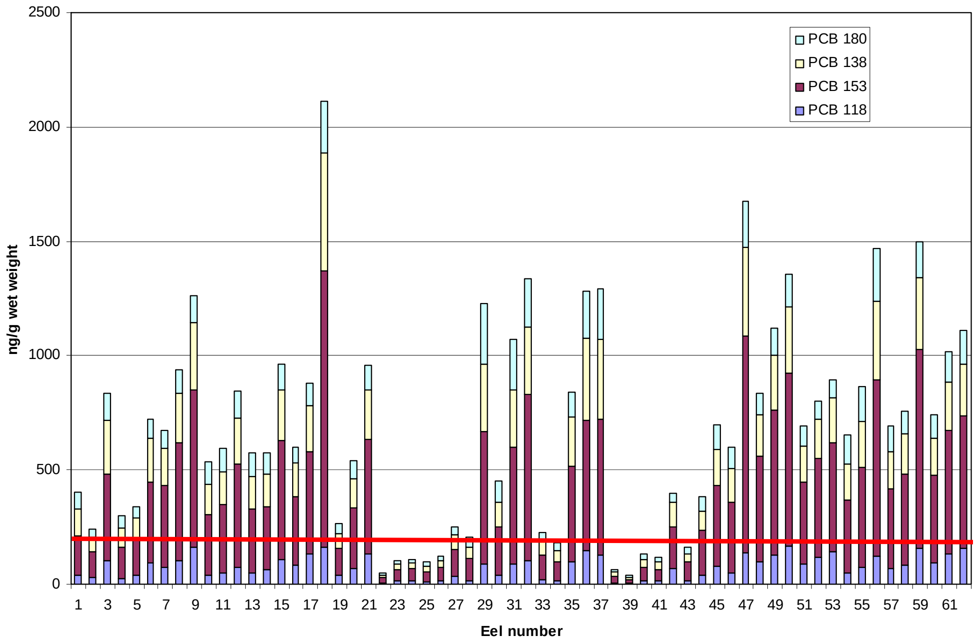


Figure 5.1: Sum of PCB 118, 138, 153 and 180 in eels from The Netherlands compared with the threshold value of ovary contamination above which impairment of reproductive success is likely to occur.

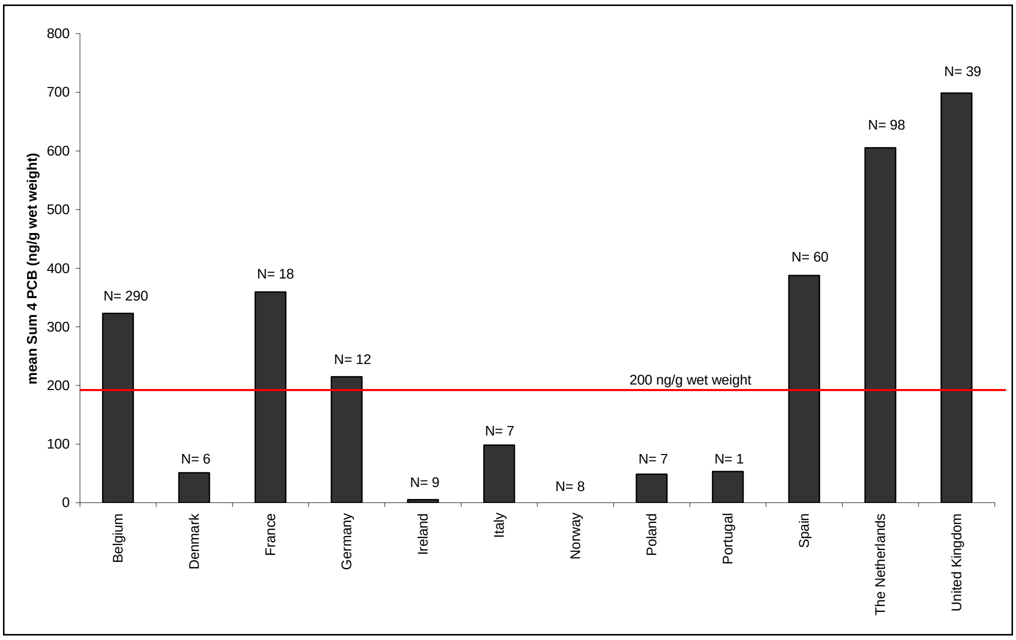


Figure 5.2: Sum of PCB 118, 138, 153 and 180 in eels from several countries in Europe compared with the PCB threshold value of ovary contamination in whiting above which impairment of reproductive success is likely to occur. Data extracted from the European Eel Quality Database. Number of sites (N) is indicated.

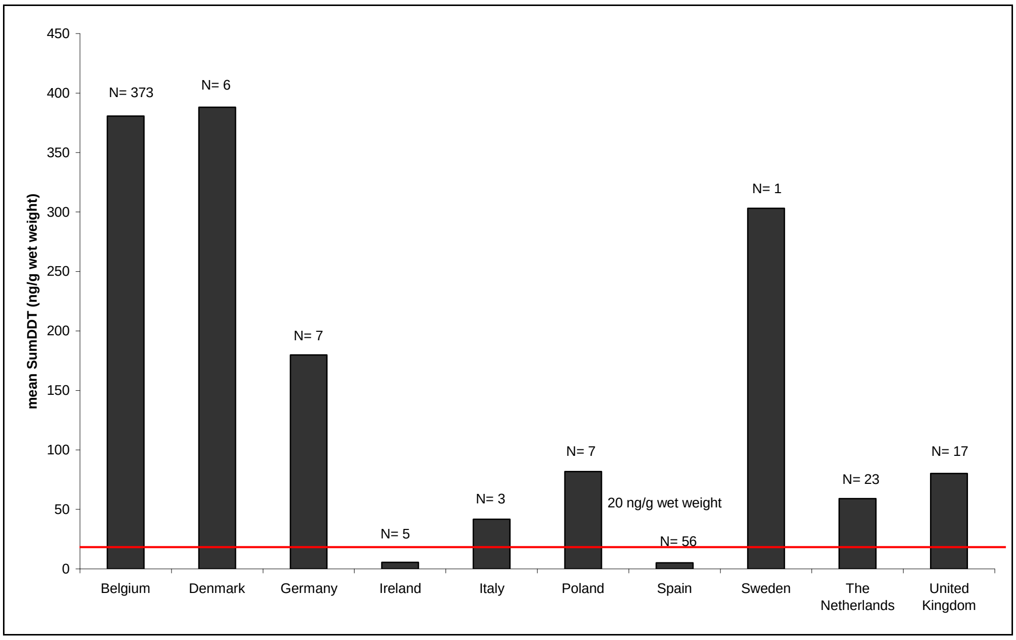


Figure 5.3: Mean of Sum of DDTs in eels from several countries in Europe compared with the Sum DDT threshold value of ovary contamination in whiting above which impairment of reproductive success is likely to occur. Data from the European Eel Quality Database. Number of sites (N) is indicated.

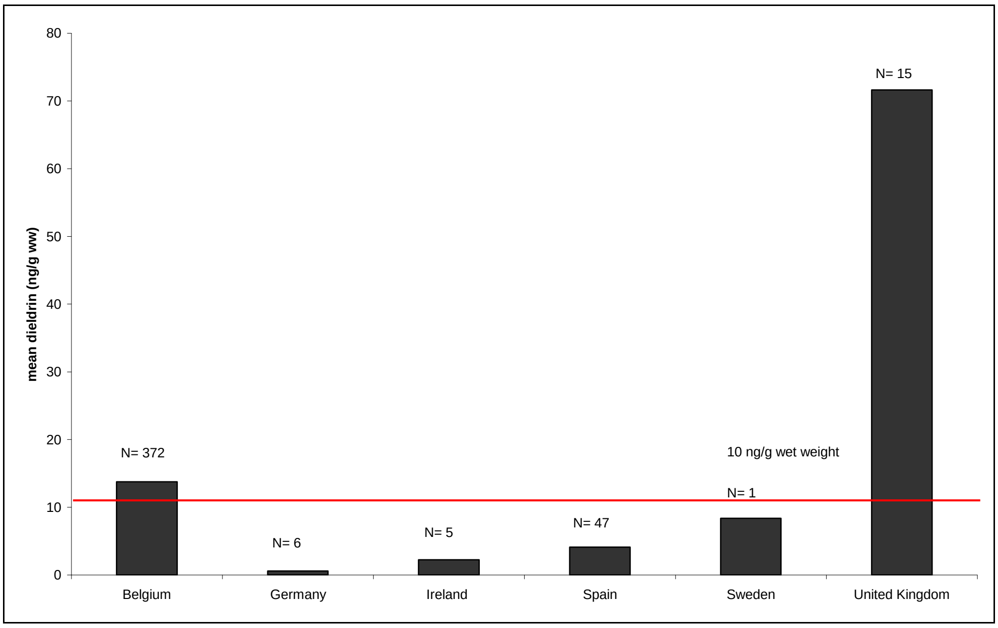


Figure 5.4: Mean of dieldrin in eels from several countries in Europe compared with the dieldrin threshold value of ovary contamination in whiting above which impairment of reproductive success is likely to occur. Data from the European Eel Quality Database. Number of sites (N) is indicated.

5.4.3 Effects of a decreased fat content on the stock

Several authors described the requirements of energy for spawners to migrate and reproduce, in terms of percentage of lipids in muscle wet weight, or on body weight basis, which is commonly assumed as equal. Boëtius and Boëtius, 1980 estimated that a minimum of 20% of total lipid on body weight basis is required for successful migration and reproduction. More recently, through experiments with eels in swimming tunnels, the energy required for migration was estimated as 7.7% (van Ginneken and van den Thillart, 2000), 12.6% (van den Thillart *et al.*, 2004), 7.8% (Palstra *et al.*, 2006a) and 6% fat (van den Thillart *et al.*, 2007). Palstra *et al.*, 2006b reported that besides 7.8% fat for migration, 5.7% is required for incorporation in oocytes, and a total of 13.5% fat is the estimated requirement for healthy migrating silver eels (Palstra *et al.*, 2007). Van den Thillart *et al.*, 2007 concluded that with eels having around 20% fat, there is more than enough left after reaching the spawning site for gonad development and spawning behaviour. However, they further discuss that at least 13% is necessary for swimming (independently of size) and on average 7.7% is incorporated in eggs indicating that silver eels should have a fat percentage of 20.7% to be able to migrate and reproduce successfully (Belpaire *et al.*, 2009).

If we assume 20% as the minimum limit for a normal migration and reproduction, we can compare this threshold to the EEQD data and new data provided.

New lipid data in yellow eels were provided for two sites on the Thames. In total 35 eels were analysed and mean lipid contents was 14.4 % ± 8.9 (Jürgens *et al.*, 2009).

The EEQD provided an overview of lipid content in eel from 12 countries (Figure 5.5). From this preliminary analysis, the fat content of eel seems to be dependent of the latitude, higher in the north and lower in the south, presumably also in relation to the body size or life stage of these eels. Fat levels may vary considerably within river but also between countries. Considering the very low fat levels among many eels (although in the yellow phase) it is probable that many of them will not contribute to the spawning stock as the energy requirements will not be met. We recommend that a better overview of the lipid content of eels (especially the silver eels) over Europe is needed.

Knösche, 2009 discussed the paper of Belpaire *et al*., 2009 and raises the question if the reduction of fat content of European eel observed in the Netherlands and Belgium is responsible for the decline of the stock. To evaluate this question he relates the results on fat content of 1146 yellow eel analysed between 1992 and 2004 and captured in the River Elbe basin, Germany. According to the author there is a significant positive relationship between fat content and weight of the eels. He observed an increase of a mean fat content of 5% for yellow eels (weight of less 130 g) to about 17% for yellow eels (weight of more than 230 g). In comparison with yellow eels, silver eels from the same basin analysed in 2007 and 2008 (n = 174) revealed a further increase in fat content of nearly 5%. This sample demonstrated a proportion of silver eels of 36% under 20% fat content estimated as a critical threshold for the capacity to sustain migration and to contribute successfully to spawning. The author concluded from his data that a general trend of decreasing fat content could not be observed in the Elbe basin and that more data from other catchments should be analysed wherever available.

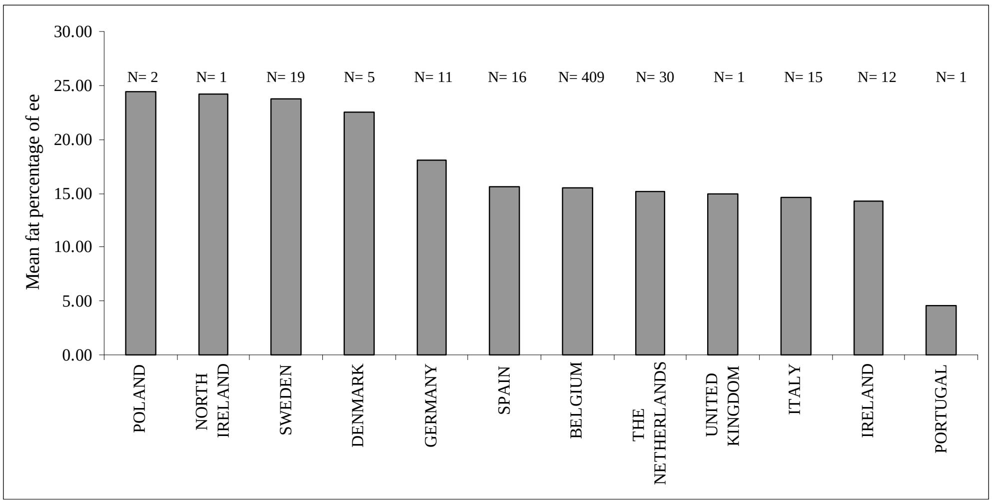


Figure 5.5: Mean fat levels in (mostly yellow) eels from the EEQD. Number of sites is indicated.

5.4.4 Effect of *Anguillicoloides crassus* on the stock

In a recent paper Palstra *et al*., 2007 investigated the swimming performance of silver eels from Lake Balaton, Hungary, by comparing a group of eels uninfected with eels infected with the parasite *Anguillicoloides crassus*. Additionally the swimming performance of a third group of eels that revealed a damaged swimbladder from a former infection was tested in a swimming tank. The study tried to address the question if the energy drain by the parasite and the damage of the swimbladder could lower the swimming performance and induce of loss of control of buoyancy. Both effects would considerably impair the migration of infected eels to the spawning grounds.

Overall 70 eels were tested in a swimming tank, 43 infected and 27 uninfected individuals. From the 27 uninfected eels 14 fish displayed a damaged swimbladder which was attributed to a former infection with the parasite. Out of the 70 fish, 27 individuals stopped swimming before reaching the final swimming speed of 0.7 m/s. The proportion of such "dropout" eels was significantly higher among individuals with a damaged swimbladder compared with healthy eels. Infected eels and eels with a damaged swimbladder displayed an optimum swimming speed which was significantly lower (by 18% and 21%, respectively) than the optimum swimming speed of healthy eels. From these findings the authors concluded that as a consequence of a minor endurance, infected eels would spend 20% more energy for migration to the spawning area. Furthermore, because of a lower optimum swimming speed the infected eels would probably need more time to reach the spawning grounds compared with healthy eels.

In conclusion the authors did demonstrate that the infection with *Anguillicoloides crassus* could impair the swimming performance of the European eel and therefore may reduce their capacity for migration and reproduction. A successful reproduction would be less probable because infected eels would need more fat and more time to reach the spawning area. However, the study did not provide a quantitative approach to conclude if infected eels irrespective of the individual parasite burden would never be able to complete migration and spawning. Nevertheless evidence is provided that eel with a damaged swimbladder from a former infection will probably not recover to the same swimming performance than non infected eels.

Recent investigations (Jakob *et al*., 2009b) clearly demonstrate, that eels staying in a purely marine environment are at little risk of getting infected with *A. crassus* (Figure 5.6). Although quantitative effects of *Anguillicoloides* infections on eel reproductive capacity are not yet fully understood, eels in saline coastal areas should be considered a valuable source of high quality spawners.

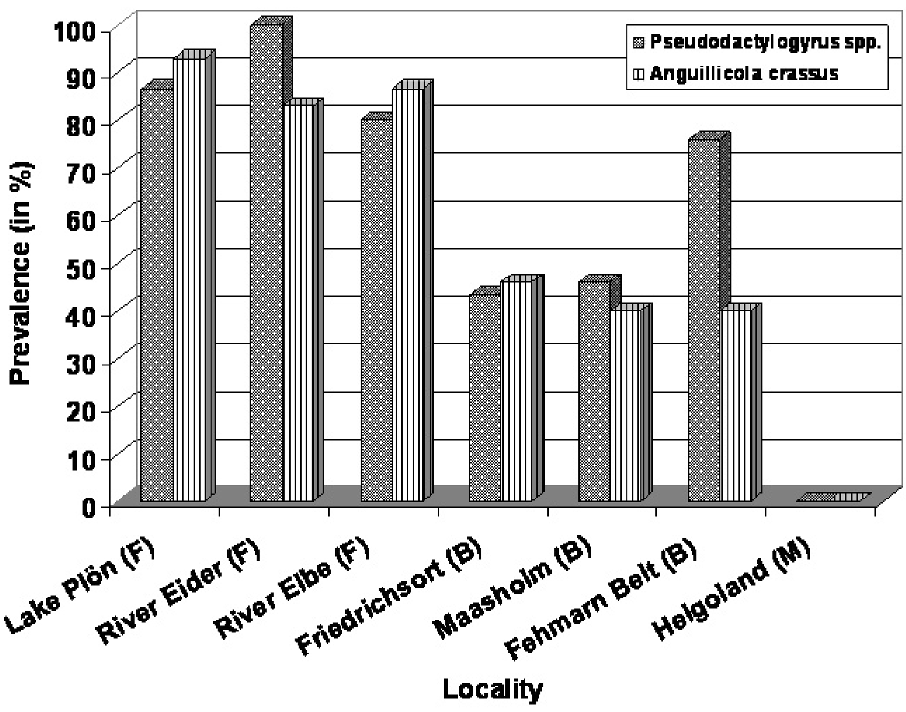


Figure 5.6: Prevalence (%) of infection for *Anguillicoloides crassus* (right columns) and *Pseudodactylogyrus* spp. (left columns) for different freshwater (F), brackish (B) and marine (M) locations in northern Germany.

5.5 Eel quality issues and future eel management

The results of a questionnaire on eel quality (contaminants and diseases), which was elaborated during the meeting and distributed to all countries participating in the WGEEL meeting, demonstrated that despite some common concerns within Europe, there are slight differences on the involvement of countries and funding for eel quality issues.

Monitoring of eel quality is carried out by all countries, except for Italy where apart from occasional surveys which are conducted within specific projects, the European eel quality is not monitored.

When comparing monitoring of contaminants vs. monitoring of diseases it is concluded that in general, countries conduct both types of monitoring except for Denmark and Estonia where contaminants are not included in the monitoring programme. *Anguillicoloides crassus* is the only disease monitored by all countries. Sixty one per cent of all countries monitor contaminants in eel.

Eel quality monitoring is conducted for several purposes which include EMP re-evaluation, human consumption, the water framework directive (WFD), national programmes and other purposes, namely special programmes for certain rivers in Germany, and the data collection regulation (DCR) in Portugal.

Most countries intend to report the results of monitoring as part of the evaluation of their EMP's in 2012 and annually in WGEEL. However, as for providing the data to EEQQ, there are stronger concerns/restrictions, with some countries raising doubts about the possibility of including their data in the database. There are costs involved and 3rd level projects may make data available but not as a national requirement.

Quality assessment of stocked material is important for all countries, but concern is focused on diseases rather than contaminants. Only the Netherlands mentioned contaminants as being part of the quality assessment of stocked material.

Norway and Canada, while present in the meeting, and having replied to the questionnaires, were not included in the analysis because the questionnaire was related to the EU Member States eel management plans. However, Canada has a national monitoring programme for eel quality that includes both contaminants and diseases.

5.6 Research needs on eel quality issues

Getting a comprehensive overview of the quality of the silver eel population (including contamination levels, biomarker responses, lipid content and condition, disease levels) all over Europe still remains an essential and urgent objective for European eel management.

An important focus should be to study the effects of contaminants and disease factors on lipid metabolism, condition, migration capacities and reproduction. New opportunities for experimental work on the reprotoxic effect of (individual or combined) contaminants on the eel are likely to show up, as controlled reproduction of *A. japonica* on experimental scale seems to be possible. Additionally, comparative studies of lipid content and lipid metabolism in yellow vs. silver eels are needed.

There is a need for research aiming at quantifying the effects of decreased eel quality on population dynamics.

Simple and easily reproducible virus-detection measures especially for rhabdoviruses (EVE and EVEX) need to be provided. This includes the development of PCR-based instead of cell-culture-based methods in order to also detect latent infections in apparently healthy eels.

Work should be continued in the development of adequate biomarkers indicating biological effects (see for example, Aubry *et al.*, 2007a; 2007b; Maes and Volkaert, 2007; Marohn *et al*., 2008) with a great sensitivity for both the concentration and length of exposure by contaminants.

5.7 Conclusions and recommendations for Chapter 5: Eel quality

5.7.1 Conclusions

Several reviews on the effects of contaminants and *Anguillicoloides crassus* on the eel have described clear ecotoxicological effects of contaminants and pathological effects of diseases and parasites, raising concern about their capacity for successful migration and reproduction.

Estimation of an effective spawner biomass requires the quantification of the adverse effects of contaminants, parasites, diseases, and low fat levels on the capacity of eel to migrate and spawn successfully.

In the absence of quantitative studies, comparisons with threshold values of toxic compounds in other fish species indicated that the body burden of compounds such as PCBs, DDT and dieldrin in eels from many parts of Europe are so high that effects at the population level are likely to occur.

Fat content in yellow eel from Belgium and the Netherlands reveals a continuous decrease during the last 20 years approaching the critical 20% level. About 36% of the silver eels from the Elbe basin revealed a fat content lower than 20%.

With regard to the precautionary approach, stocking of eel in waters with presence of this parasite may not be a sustainable management measure. Emphasis is therefore put on the fact that eel in the marine environment represents a valuable resource with regard to absence of *Anguillicoloides crassus.*

Many EU Member States have indicated that eel quality issues will be taken into account when planning future stocking as a management measure especially with regard to infection by *Anguillicoloides crassus* and other pathogens. However, in most European countries monitoring programmes are mostly focused on *A. crassus*. Likewise, monitoring of quality parameters at sites proposed for stocking seems to be inadequate and there are many proposals for stocking of habitats that are known to be highly polluted.

5.7.2 Recommendations

Establish a comprehensive overview with improved spatial coverage of the quality of the silver eel population across Europe is an essential and urgent requirement.

More extensive research involving dose-effect studies is necessary in order to evaluate how, and at what concentrations, pollutants are detrimental to eel.

In the absence of data on the quantitative effects of contaminants for eel, comparisons of the effects of relevant contaminants on other fish species may be a useful alternative approach. The WG recommends this helpful, low cost approach until more quantitative toxicological data on eel become available.

Considering the increasingly limited availability of glass eel for restocking, it is recommended to stock waters of good quality, thereby producing eels with a high capacity for successful reproduction.

The advantages of using the European eel (*Anguilla anguilla*) as an chemical indicator species within the WFD has been described (Belpaire and Goemans, 2007a and b). A wide range of studies over Europe exist and have pinpointed various types of environmental contamination. Eel contaminant profiles seem to be a fingerprint of the contamination pressure of a specific site (Belpaire *et al.*, 2008). Reference values and quality classes for PCBs, OCPs and heavy metals in eel are available. Given, however, the critically endangered status of the eel (IUCN) it is recommended that the benefit from sampled eels should be optimized and eels sacrificed under the eel Regulation and DCR for age determination and parasites should also be made available for contaminants analysis under the Waterframework Directive.

6 Advances in eel science

Chapter 6 reviews any significant new research findings, particularly in relation to advances in artificial reproduction and oceanic factors. Reference is made to other Anguillid species (ToR h.).

> h) report on improvements to the scientific basis for advice on the management of European and American eel.

6.1 Recent genetic findings

6.1.1 *Anguilla anguilla*

Previous studies of the genetic structure in the European eel have resulted in seemingly conflicting results (Wirth, 2001; Maes *et al.*, 2006) ranging from no detectable heterogeneity to small but statistically significant differences and isolation by distance patterns among eels sampled across the continental range. Differences with respect to sampling design and choice of molecular markers combined with a lack of power estimates have complicated comparisons of results from existing studies. Palm *et al.*, 2009 compared maturing silver eels of known age from southern and northern Europe (Italy and Baltic Sea). In comparison with previous studies their data gave a better representation of potential spawning stocks because eels were sampled after they'd begun their migration towards their spawning grounds. Despite large sample sizes (>1200 eels) no signs of genetic differentiation were observed and subsequent power analysis demonstrated that the true level of heterogeneity must be exceedingly small to have remained undetected.

Similar comparative work across continental range by Pujolar *et al.*, 2009 using glass eel found that hierarchical analysis of molecular variance indicated a non-significant difference between regions (Mediterranean vs. Atlantic) which contrasted with the significant differences observed between glass eel samples within regions. Their interpretation was that the existence of a single spawning site for all *A. anguilla* individuals and extensive migration loop with great opportunity for mixing of individuals might explain the homogeneity in genetic composition found between regions. These findings from both of these studies have reiterated the notion that previous reports of continental genetic differentiation in the eel may be largely explained by uncontrolled temporal variations between juvenile glass eel samples and added further credibility to the Panmixia hypothesis.

6.1.2 *Anguilla rostrata*

A variety of projects investigating *A. rostrata* population genetics in Canada are currently underway and cover many innovative aspects of eel genetics with the main objective being the documentation of any phenotypic and genetic variability of *A. rostrata* colonizing different habitat types in North America (Coté *et al.*, 2009). This work will provide the characterization of the neutral genetic population structure of the American eel (elver and yellow eel stages) along its North American distribution range using 25 microsatellite loci to achieve high power thus enabling a review of the hypothesis of panmixia in *A. rostrata*. The development stages of glass eels and elvers will also be characterized at the phenotypic and transcriptomic levels for eels originating in two regions with different sex ratios. For that purpose, growth rates, sex determination and gene expression will be compared in a controlled environment for eel groups originating in the two different regions. The final aspect of this work will examine epigenetics in eels as a potential mechanism for explaining phenotypic variability (Pigliucci, 2003; Bossdorf *et al.*, 2008). Epigenetics refers to all gene expression modifications caused by environmental variability that is heritable but does not result in nucleotide modifications.

6.2 Artificial reproduction of *Anguilla anguilla*

Although yellow eel and silver eels are fished and purchased for human consumption, aquaculture and stocking rely exclusively upon their supply of seed stock from glass eels caught in nature. The development of a self sustaining aquaculture industry has prompted investigations into the reproduction of the European eel in captivity (Pederson, 2003; Palstra *et al*., 2005). Such investigations may ultimately relieve pressure on the requirement of glass eel seed stock and thus leave a greater proportion of glass eels which could be used in stocking programmes as per eel management plan requirements. Even though research in Japan has progressed with the successful production of glass eels of the Japanese eel (Tanaka *et al*., 2003) large-scale production of glass eel for commercial purposes is still not possible for any species of *Anguilla* and both aquaculture and stocking continue to rely on the capture of wild eels. The complexity of the eel life cycle with the inhibition of gonadal development until late phase in their migration means that hormonal inducement of pubescent silver eel is still a prerequisite to gamete production (EELREP, 2005). A successive series of Danish projects has brought larval development of artificially reared *A. anguilla* a long way extending the longevity of such larvae to 18 days post-hatch in 2008 during a first-feeding experiment (Tomkiewicz and Sorensen, 2009).

This Danish research continues until 2010 under the project "Reproduction of European Eel in Culture" (REEL).

6.2.1 International collaboration in European eel reproduction

Following a call for research funding from the EU (FP7-KBBE-2009–3) on the reproduction of eel in captivity, a consortium based project PRO-EEL (Reproduction of European Eel: Towards a Self-sustained Aquaculture) was designed and submitted for funding in 2009. The objective of PRO-EEL will be the development of standardized protocols for the production of high quality gametes, viable eggs and feeding larvae. The approach will be focused on the expansion of knowledge in relation to the intricate hormonal control and physiology of eels which complicates artificial reproduction techniques. This knowledge will be applied to the development of methods for the inducement of gametogenesis taking into consideration broodstock selection criteria and rearing conditions. Additional knowledge concerning the functional anatomy of embryos and yolksac larvae will be applied to the development of suitable rearing conditions and larval feed (current obstacles). This integrated approach towards the development of suitable protocols and functional technology will ultimately be evaluated against the relative production of healthy embryos/ larvae and the reproducibility of the techniques involved.

6.2.2 Artificial reproduction of *Anguilla rostrata*

The catadromous life cycle of the American eel, coupled with spawning occurring somewhere in the Sargasso Sea, has limited our understanding of the reproductive biology of the species. Whereas gametogenesis begins in the freshwater phase, final maturation and spawning have never been observed. The American eel is a panmictic species, and some evidence suggests it is in a state of decline. This decline may be the result of eels spending many years accumulating contaminants then passing these on to offspring during reproduction, and therefore reducing spawning success. This study was designed to determine if American eels could be matured and fertilized in the laboratory. Eels were collected while migrating from freshwater at the onset of the silver migration in the autumn of 2007. Males were maintained in a recirculation freshwater system and received weekly injections of Human Chorionic Gonadatropin (HCG). Females were maintained in a flow through marine system that was maintained at 20ºC and given weekly injections of Salmon Pituitary Extract (SPE). Males produced viable sperm after 4 weeks of injection and females reached maturity in 7–11 weeks. Final maturation in females was determined by a combination of weight increases and egg size and condition determined by biopsy. Upon reaching final maturation females were induced to ovulate by a single injection of (17α,20β-Dihydroxy-4-pregen-3-one; DHP). Fertilization could be confirmed after 4 hrs by the observation of embryos at the 16–32 cell stage. Somite formation was observed after 24 hrs and hatching occurred 32–72 hrs after fertilization. This is the first laboratory fertilization that has resulted in complete embryogenesis and hatching for the species and provides an opportunity to examine aspects of the reproductive biology previously unavailable.

6.3 Advances in Japanese eel (*Anguilla japonica*) science

Although European and American scientists have had limited success in uncovering the offshore spawning migration and reproductive biology of the Atlantic eels *Anguilla anguilla* and *Anguilla rostrata*, Japanese researchers have had recent successes with the discovery of spawners of the Japanese eel (*Anguilla japonica*) at their spawning grounds west of the Mariana Islands (Chow *et al*., 2009), caught pre-leptocephali (Tsukamoto, 2006) and artificially closed their reproductive cycle (Tanaka *et al*., 2001).

6.3.1 Spawning migration

Given that oceanic observations of migrating silver eels are remarkably scarce (Wenner, 1973; Ernst, 1977; Bast and Klinhardt, 1988), the development of transmitters and techniques to track migration routes has developed rapidly in the last few years. In particular the release of silver eels tagged with pop-up satellite transmitters has recently been intensified with initial results indicating a dial vertical migration in medium to upper depth (Westerburg *et al*., 2007). Whereas reported migration movements of New Zealand longfin eels (*Anguilla dieffenbachii*) range between close to the surface to 980 m deep (Jellyman and Tsukamoto, 2005), Japanese eel are reported to migrate in diurnal cycles from depths between <400 to 600 m (Tsukamoto, 2009). Similar investigations for European eel have been performed as part of the Galathea project and are an integral component of the ongoing Eeliad project. First results demonstrating diurnal vertical movement during migration have been submitted to press.

6.3.2 Identification of *A. japonica* spawning grounds

The capture of post-spawning adult Japanese eel near the assumed spawning grounds west of the Mariana ridge in the North Equatorial Current was a breakthrough in oceanic eel research (Chow *et al*., 2009). Previously in 2005, the Ocean Research Institute of the University of Tokyo found the first ever pre-leptocephalus larvae of *A. japonica*. Only 4 to 5 mm length, and presumed as a few days post-hatching in the region west of the Mariana Islands, this finding proved that *A. japonica* spawned in this area (Tsukamoto, 2006). These findings were taken further in 2008 when 5 adult eels were captured in the ocean; 3 of them 130 km southeast from Suruga Seamount at the new moon in June; and 2 of them 30 km southeast from Suruga Seamount at the new moon in August (Chow *et al*., 2009). The synchronization of spawning in the Japanese eel is thought to be triggered by the lunar cycle with spawning taking place at the new moon each month throughout the spawning season

(Tsukamoto *et al*., 2003; Tsukamoto, 2009). In addition, during 3–4 September 2008, 26 pre-leptocephali were collected in the area where the adult females had been caught, again suggesting that spawning occurred in this area (Tsukamoto, 2009). On the basis that small, recently hatched larvae of Atlantic eels were constantly found south of distinct temperature fronts in the Subtropical Convergence Zone of the Sargasso Sea (Kleckner and McCleave, 1988), the spawning ground of Japanese eel was hypothesized to be defined by salinity fronts typically formed at the northern edge of North Equatorial Current of the North Pacific Ocean (Tsukamoto, 1992). Employing this hypothesis and the subsequent captures of early leptocephalus stages and adult eels close to three seamounts in this area (Suruga, Arakane and Pathfinder) led to the hypothesis of seamounts as "landmarks" for the Japanese eel spawning area (Tsukamoto *et al*., 2003; Tsukamoto, 2006) and lead onward to the discovery of the spawning ground in 2008 (Chow *et al*., 2009). Narrowing down the spawning area of Atlantic eels was one of the major goals of the Danish Galathea expedition in 2007. However, successes similar to those achieved for the Japanese eel have yet to be realized for eels in the Atlantic.

6.3.3 Glass eel production

Attempts to induce artificial maturation in the Japanese eel (*Anguilla japonica*) started in the 1960s. Yamamoto and Yamaouchi, 1974 were the first to successfully obtain fertilized eggs and larvae after hormonal maturation of silver *A. japonica*. Despite a series of successful attempts to produce pre-leptocephalus larvae (Satoh, 1979; Wang *et al*., 1980), their subsequent rearing to advanced larval or even glass eel stage was prevented by the absence of suitable larval feeds. Tanaka *et al*., 2003 were the first to successfully produce glass eels in captivity after designing a slurry-type diet made from shark egg yolk powder which was a suitable substitute food for captive-bred eel larvae. Although the artificial production of glass eels in Japan has still not reached an industrial level, it is performed on a regular and steady basis.

However following the recent CITES Appendix II listing of the *Squalus spp*. used in this work, *Squalus* eggs are no longer in sustainable supply and the feeding of early life stages still remains a scientific challenge. Recent investigations on this topic include the identification and extraction of the chemical compounds responsible for the stimulation of eel leptocephali to feed on this particular diet.

(Convention on International Trade in Endangered Species of wild fauna and flora (CITES) 2007. Proposal 18 COP14 on the European Eel (*Anguilla anguilla*) 3–15 June 2007, Netherlands.)

6.4 Special issue of Journal of Fish Biology devoted to *Anguillid* eels

Publication of a Special Issue of the *Journal of Fish Biology* on Anguillid Eels Vol. 74 No. 9, June 2009.

6.5 Conclusions and recommendations for Chapter 6: Advances in eel science

6.5.1 Conclusion

Most elements of the natural reproduction of *A. anguilla* and *A. rostrata,* including their migration routes and spawning grounds, still remain unknown, although investigations into their artificial reproduction are yielding some useful information.

6.5.2 Recommendations

It is recommended that there is continuing research into the reproductive process, with particular emphasis on the effects and threshold levels that repro-toxins may have on spawner quality and continued research into improving early larval survival.

7 Research needs

A detailed proposal from three priority research needs was presented in the 2008 WGEEL report (ICES 2008a). These needs have not changed.

8 References

Adam, G., Feunteun, E., Prouzet, and P., Rigaud, C. 2008. L'anguille eurpéenne. Indicateurs d'abondance et de colonisation. Ed Quae. 400p.

Aieta, A.E. and Oliveira K. 2009. Distribution, prevalence, and intensity of the swimbladder parasite *Anguillicola crassus* in New England and eastern Canada. Diseases of Aquatic Organisms. 84: 229–235.

Andersson, J.; Sandstroe, O. M and Hansen, H. J. M. 1991: Elver (*Anguilla anguilla* L.) stockings in a Swedish Thermal effluent recaptures, growth and body condition. Journal of Applied Ichthyology Vol. 7: 78–89.

Antunes, C. 1999. *Anguillicola* infestation of eel population from the Rio Minho (North of Portugal). ICES/EIFAC, 20–24 September, Silkeborg, Denmark.

Aström, M. and Dekker, W. 2007. When will the eel recover? A full life cycle model. Ices Journal of Marine Science **64** 7: 1491–1498.

Aubry E, Cagnon C, Lalanne Y. 2007a. Quantification of Increase in Hepatic CYP1A1 mRNA by Real time RT-PCR after Exposure of the European Eel (*Anguilla anguill*a) to a Diesel Oil Water Soluble Fraction. Environ Bioind 2(1): 47–51.

Aubry E, Cagnon C, Lalanne Y. and Mouchès C. 2007b. Assessment of young yellow European eel *Anguilla anguilla* L. exposure to a CYP1A1 inducer by the quantification of increase in hepatic CYP1A1 mRNA using real time RT-PCR. J Fish Biol 71(C): 470–477.

Aubry, E., Cagnon, C., Lalanne, Y., and Mouchès, C. 2007b. Assessment of young yellow European eel *Anguilla anguilla* L. exposure to a CYP1A1 inducer by the quantification of increase in hepatic CYP1A1 mRNA using real time RT-PCR. J Fish Biol 71(C): 470–477.

Bast, H.D. and Klinkhardt, M.B. 1988. Catch of a silver eel (*Anguilla anguilla* (L., 1758)) in the Iberian Basin (Northeast Atlantic) (Teleostei: *Anguillidae*). *Zoologischer Anzeiger* 221, 386–398.

Beaulaton, L. 2008. Systèmes de suivi des pêches fluvio-estuariennes pour la gestion des espèces : construction des indicateurs halieutiques et évaluation des impacts en Gironde. PhD Agrosystèmes, Ecosystèmes et Environnement. Institut National Polytechnique de Toulouse, Toulouse, p. 348.

Belpaire, C., and Goemans, G. 2007a. Eels: contaminant cocktails pinpointing environmental contamination. ICES Journal of Marine Science 64, 1423–1436.

Belpaire, C. and Goemans, G. 2007b. The European eel (*Anguilla anguilla*) a rapporteur of the chemical status for the Water Framework Directive? Vie et Milieu – Life and Environment 57 (4), 235–252.

Belpaire, C. 2008. Pollution in eel. A reason for their decline? PhD. thesis Catholic University of Leuven, INBO.M.2008.2. Instituut voor Natuur- en Bosonderzoek, Brussels, 459 pages, III annexes.

Belpaire, C., Goemans, G., Geeraerts, C., Quataert, P., Parmentier, K. 2008. Pollution fingerprints in eels as models for the chemical status of rivers. ICES Journal of Marine Science, 65: 1483–1491.

Belpaire CGJ, Goemans G, Geeraerts C, Quataert P, and Parmentier K. 2009. Decreasing Eel stocks: Survival of the Fattest? Ecol Freshw Fish 18(2): 197–214(18).

Bevacqua, D, De Leo, G., Gatto, M., Melia, P., and Crivelli, A. 2009. A long term study on eel population of Camargue lagoon, Southern France. Presented to Workshop on eel in Saline Waters, 4–7 September 2009, University of Gothenburg.

Bergesen, K.A., Pettersen, K. and Larsen, B.M. 2009. NINA Forskningsstasjon, Ims. Årsmelding 2008. NINA Rapport 494: 1–24. (In Norwegian).

Bisgaard, J. and Pedersen, M. I. 1991. Mortality and growth of wild and introduced cultured eels (*Anguilla anguilla* (L.)) in a Danish stream, with special reference to a new tagging technique. Dana Vol. 9: 57–69.

Boëtius J and Boëtius I. 1980. Experimental maturation of female silver eels, *Anguilla anguilla*. Estimates of fecundity and energy reserves for migration and spawning. Dana 1: 1–28.

Bossdorf, O., Richards, C.L. and Pigliucci, M. 2008. Epigenetics for ecologists. *Ecology Letters* **11**, 106–115.

Bordajandi, L. R., Gómez, G., Fernández M. A., Abad, E., Rivera, J., and González, M. J. 2003. Study on PCBs, PCDD/Fs, organochlorine pesticides, heavy metals and arsenic content in freshwater fish species from the River Turia (Spain). Chemosphere 53: 163–171.

Briand, Sauvaget, Beaulaton, Girard, Véron, and Fatin. 2009. Push net fisheries are responsible for injuries and post fishing mortalities in glass eel (*Anguilla anguilla*). Unpubl. Draft report made available to WGEEL.

Caddy, J.F. and Bazigos, G.P. 1985. Practical Guidelines for statistical monitoring of fisheries in manpower limited situations. FAO *Fisheries Technical Paper* 257: 86p.

Castelnaud G. and Beaulaton L. 2008. Indicateurs d'abondance et de pression issus des pêcheries. Chapitre 6 in L'anguille Européenne, indices d'abondance et de colonisation, Adam G., Feunteun E., Prouzet P., Rigaud C. (Coord.), Projet Européen Intereg Indicang. Edition QUAE. pp. 189–220.

Chow, S., Kurogi, H., Mochioka, N., Kaji, S., Okazaki, M. and Tsukamoto, K. 2009. Discovery of mature freshwater eels in the open ocean. *Fisheries Science* 75, 257–259.

Clevestam, P. and Wickström, H. 2008. Rädda ålen och ålfisket! -Ett nationellt bidrag till en Europeisk förvaltningsplan. Slutrapport från pilotprojekt till Fonden för fiskets utveckling Dnr: 231–1156–04, 42 (in Swedish).

Convention on International Trade in Endangered Species (CITES 2007). Consideration of proposals for amendment of Appendcies I and II (CoP 14 Proposal 16).

Cote, C.L., Castonguay M., Verreault G. and Bernatchez, L. 2009. Differential effects of origin and salinity rearing conditions on growth of glass eels of the American eel, *Anguilla rostrata*: implication for stocking programmes. *Journal of Fish Biology* 74: 1934–1948.

Dahl, J. 1967. Some recent observations on the age and growth of eels. Proceeding of the 3rd British Coarse Fish Conference, Liverpool, 3; 48–52.

Dekker, W. 2000. A Procrustean assessment of the European eel stock. Ices Journal of Marine Science **57** 4: 938–947.

Dekker, W., Pawson, M., Walker, A., Rosell, R., Evans, D., Briand, C., Castelnaud, G., Lambert, P., Beaulaton, L., Åström, M., Wickström, H., Poole, W. R., McCarthy, T. K., Blaszkowski, M., De Leo, G. A. and Bevacqua, D. 2006. Restoration of the European eel population; pilot studies for a scientific framework in support of sustainable management: SLIME. Report of FP6-project FP6-022488**:** 23.

Dekker, W. 2008. Coming to Grips with the Eel Stock Slip-Sliding Away. pages 335–355 in M.G. Schlechter, N.J. Leonard, and W.W. Taylor, editors. International Governance of Fisheries Eco-systems: Learning from the Past, Finding Solutions for the Future. American Fisheries Society, Symposium 58, Bethesda, Maryland.

Domingos, I. 2003. *A enguia-europeia, Anguilla anguilla (L., 1758), na bacia hidrográfica do Rio Mondego.*[The European eel (Anguilla anguilla (L.1758) in the Mondego River catchment]. PhD thesis, Universidade de Lisboa.

EELREP. 2005. Estimation of the reproduction capacity of European eel. Final Report www.fishbiology.net/eelrepsum

EFSA. 2008: ANIMAL WELFARE ASPECTS OF HUSBANDRY SYSTEMS FOR FARMED EUROPEAN EEL. Scientific Report of the Working Group on Eel Welfare (Question No EFSA-Q-2006–149).

Elie, P. and Girard. P. 2009. Effets des micropolluants et des organismes pathogènes chez l'anguille européenne *Anguilla anguilla* L. 1758. Collection Étude CEMAGREF N°128.

Ernst, P. 1977. Catch of an eel (*Anguilla anguilla*) northeast of the Faroe Islands. *Annales Biologiques* 32, 175.

Evans D., and Grainger R. 2002. Gathering data for resource monitoring and fisheries management. In Handbook of fish biology and fisheries. Hart P.J.B. and ReynoldJ.D. ed. Oxford, UK: Blackwell : 84–102.

FAO. 1999. Guidelines for the routine collection of capture fishery data. FAO Fisheries Technical Paper. No. 382, Rome, FAO 1999. 113p.

Geeraerts C., Goemans G., Belpaire C. 2007. (Dutch) Ecologische en ecotoxicologische betekenis van verontreinigende stoffen gemeten in paling. MIRA/2007/05; INBO/R/2007/40. INBO, Groenendaal-Hoeilaart, pp 241 Palstra *et al*., 2006.

Geeraerts, C., Belpaire, C., in prep. The effects of contaminants in European eel: a review. Ecotoxicology.

Gilles, A., Feunteun, E., Prouzet, P., and Rigaud, C. 2008 L'anguille européenne. Indicateurs d'abondance et de colonisation. Ed Quae. 400p.

Hadley Wickham. 2009. ggplot2: An implementation of the Grammar of Graphics. R package version 0.8.3.

Hanel, R. 2009. The effects of ambient salinity on eel spawner quality. A paper presented to the ICES Study Group on Eels in Saline Waters SGAESAW, Gothenburg, Sweden September 2009.

Helder, T. 1980. Effects of 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) on early life stages of the pike (*Esox lucius L.*). Sci. Total Environ. 14 (3), 255–264.

Hoek-van Nieuwenhuizen M and Kotterman KJJ. 2007. (Dutch) Biologische Monitoring Zoete Rijkswateren: Microverontreinigingen in rode aal - 2006. Imares report C001/07. IMARES, pp 45.

Hoogenboom, L.A.P, M.J.J. Kotterman1, M. Hoek-van Nieuwenhuizen1, M.K. van der Lee, W.A. Traag. 2007. Onderzoek naar dioxines, dioxineachtige PCB's en indicator-PCB's in paling uit Nederlandse binnenwateren. Imares report 2007.003 February 2007.

Hugla, J. L. and J. P. Thomé. 1999. Effects of Polychlorinated Biphenyls on Liver Ultrastructure, Hepatic Monooxygenases, and Reproductive Success in the Barbel. Ecotoxicology and Environmental Safety 42, 265–273.

ICES. 2000. Report of the EIFAC/ICES Working Group on Eels, Silkeborg, Denmark, 20–24 September 1999. ICES C.M. 2000/ACFM:6.

ICES. 2002a. Report of the EIFAC/ICES Working Group on Eels: 55p. Copenhagen: ICES.

ICES. 2002b. International Council for the Exploration of the Sea. ICES cooperative research report N° 255, Report of the ICES Advisory Committee on Fishery Management, 2002: 391–399.

ICES, 2003. Report of the EIFAC/ICES Working Group on Eels, 2–6 September 2002, Nantes, France. ICES CM 2003/ACFM:06.

ICES/EIFAC. 2004. Report of the ICES/EIFAC Working Group on Eels, 7–11 October 2003, Sukarrieta, Spain. ICES CM 2004/ACFM:09.

ICES. 2005. International Council for the Exploration of the Sea. Report of the ICES/EIFAC Working Group on Eels. ICES C.M. 2005/ I:01.

ICES. 2006. Report of the 2006 Session of the Joint EIFAC/ICES Working Group on Eels. CM2006/ACFM, 16: 352p.

ICES. 2007. Report of the 2007 Session of the Joint EIFAC/ICES Working Group on Eels. CM2007/ACFM, 23: 142p and country reports.

ICES, 2008a. The report of the 2008 Session of the Joint EIFAC/ICES Working Group on Eels, September 2008; *ICES CM 2009/ACOM:15.210pp* and country reports.

ICES. 2008b Evaluation of MS Netherlands – version 2. Published by NL Government.

Jakob, E., Neuhaus, H., Steinhagen, D., Luckhardt, B. and R. Hanel. 2009a. Monitoring of Herpesvirus *anguillae* (HVA) infections in European eel, *Anguilla anguilla* (L.), in northern Germany. J. Fish Dis. 32 (6): 557–561.

Jakob, E., Zumholz, K., Klimpel, S. and R. Hanel. 2009b. Habitat dependent parasite infestations of the European eel *Anguilla anguilla* (L.) in northern Germany. ICES J. Mar. Sc. 66: 358–366.

Jellyman, D. and Tsukamoto, K. 2005. Swimming depths of offshore migrating longfin eels *Anguilla dieffenbachii*. *Marine Ecology Progress Series* 286, 261–267.

Jürgens, M., Johnson, A., Chaemfa, C., Jones, K. and Hughes, D. 2009. The organic chemical contamination of eels in the lower Thames in 2007. A report by CEH prepared for Darryl Clifton-Dey of the Environment Agency for England and Wales, Thames Region, UK.

Kangur, A., Kangur, P. and Kangur K. 2002. The stock and yield of the European eel *Anguilla anguilla* (L.), in large lakes of Estonia. Proc. Estonian Acad. Sci. Biol. Ecol., 51/1: 45–61.

Kime, D.E. 1995. The effects of pollution on reproduction in fish. Reviews in fish Biology and Fisheries 5: 52–96.

Kleckner, R. C. and McCleave, J. D. 1988. The northern limit of spawning by Atlantic eels (*Anguilla* spp.) in the Sargasso Sea in relation to thermal fronts and surface water masses. *Journal of Marine Research* 46, 647–667.

Knights, B., and White, W. 1998. An appraisal of Stocking Strategies for the European Eel, *Anguilla*. In I. G. Cowx (Ed.), Stocking and Introductions of Fish: 121–140. Oxford: Fishing. News Books.

Knights, B. 2003. Enhancing stocks of European eel, *Anguilla anguilla*, to benefit bittern, *Botaurus stellaris*. In I. G. Cowx (Ed.), Interactions between fish and birds: Implications for management: 298–313. Oxford, UK: Blackwell Science.

Knösche, R. 2009. Aalrückgang - Schlüsselfaktor Fettgehalt? Fisher and Teichwirt 8/2009 284–287.

Lambert, P. 2008. Évaluation des effets possibles de différents niveaux de réduction des impacts sur le temps de restauration du stock d'anguille européenne, Rapport Cemagref**:** 15 p.

Lambert, P., Beaulaton, L., Daverat, F., Rigaud, C. 2006. Assessment of eel stock status in Garonne and Dordogne water bodies by analysing length structures. In: Ices (Ed.), Annual science conference. ICES, Maastricht, Netherland, ICES CM 2006/J: 07, p. 13.

Lawrence A. and Hemingway K. 2003. Effects of Pollution on Fish: Molecular Effects and Population Responses. Blackwell Science.

Limburg, K. E., Wickström, H., Svedäng, H., Elfman, M. and Kristiansson, P. 2003. Do Stocked Freshwater Eels Migrate? Evidence from the Baltic Suggests "Yes". In Biology, Management and Protection of Catadromous Eels, ed. Dixon, D. A. (American Fisheries Society, Symposium 33, Bethesda, Maryland), pp. 275–284.

Lyndon, A.R. and Pieters, N. 2005. The first record of the eel swimbladder parasite *Anguillicola crassus* (*Nematoda*) from Scotland. *Bulletin of the European Association of Fish Pathologists*, **25**, 82–85.

Maes, G.E., Pujolar, J.M., Hellemans, B. and Volckaert, F.A.M. 2006. Evidence for isolation by time in the European eel (*Anguilla anguilla* L.) *Molecular Ecology* 15: 2095–2107.

Maes, G.E., and Volkaert, F.A.M. 2007. Challenges for genetic research in European eel management. ICES J Mar Sci 64: 1463–1471.

Marohn, L., Rehbein, H., Kündiger, R. and Hanel, R. 2008. The suitability of cytochrome-P4501A1 as a biomarker for PCB contamination in European eel (*Anguilla anguilla*). Journal of Biotechnology 136 (2008) 135–139.

Mo, T.A. 2009. Dødelig asiatisk åleparasitt spres i norsk fauna. Norsk Veterinærtidsskrift no. 4/2009: 350–353. (In Norwegian).

Monosson E. 2000. Reproductive and developmental effects of PCBs in fish: a synthesis of laboratory and field studies. Reviews in Toxicology 3: 25–75.

Nash, R., Valencia, A. and Geffen, A. 2006. The origin of Fulton's conditio factor – setting the record straight. Fisheries 31: 236–238.

Neto, A.F., Costa, J.L., Costa, M.J. and Domingos, I. Accepted. a). Epidemiology and pathology of *Anguillicoloides crassus* in the European eel, *Anguilla anguilla*, from the Tagus estuary (Portugal). *Journal of Aquatic Diseases*.

Neto, A.F., Passos, D., Costa, J.L., Costa, M.J., Caçador, I., Pereira, M.E., Duarte, A.C., Pacheco, M. and Domingos, I. Submitted. b). Metal concentrations in the European eel, *Anguilla anguilla* (L., 1758), in estuaries and coastal lagoons from Portugal. *Environmental Monitoring and Assessment*.

Palm, S., Dannewitz, J., Prestegaard, T. and Wickstrom, H. 2009. Panmixia in European eel revisited: no genetic difference between maturing adults from southern and northern Europe; *Heredity*, pp 1–8.

Palstra, A.P., van Ginneken, V.J.T., Murk, A.J. and van den Thillart, G.E.E.J.M. 2006a. Are dioxin-like contaminants responsible for the eel (*Anguilla anguilla*) drama? Naturwissenschaften 93: 145–148.

Palstra, A.P., Antonissen, E., Clavero, M.E., Nieveen, M., Niemantsverdriet, P., van Ginneken, V.J.T. and van den Thillart, G.E.E.J.M. 2006b. The fate of fat in silver eels: lipid requirements for spawning migration. In: Palstra, A.P. Energetic requirements and environmental constraints of reproductive migration and maturation of European silver eel (*Anguilla anguilla* L.). PhD thesis. Leiden, The Netherlands: University of Leiden. 184 pp.

Palstra, A.P., Cohen, E.G.H., Niemantsverdriet, P.R.W., van Ginneken, V.J.T. and van den Thillart, G.E.E.J.M. 2005. Artificial maturation and reproduction of European silver eel: Development of oocytes during final maturation. *Aquaculture* 249: 533–547.

Palstra, A.P., Heppener, D.F.M., van Ginneken, V.J.T., Székely, C. and van den Thillart, G.E.E.J.M. 2007. Swimming performance of silver eels is severely impaired by the swim-bladder parasite *Anguillicola crassus*. Journal of Experimental Marine Biology and Ecology, doi:10.1016/j.jembe., 2007. In press.

Pedersen, M. I. 1998. Recapture rate, growth and sex of stocked cultured eels *Anguilla anguilla* (L.). Bulletin Francais de la Peche et de la Pisciculture. 349:153–162.

Pedersen, M. I. 2000. Long-term survival and growth of stocked eel, *Anguilla anguilla* (L.), in a small eutro-phic lake. Dana. 12:71–76.

Pederson, B.H. 2003. Induced sexual maturation of the European eel *Anguilla anguilla* and fertilisation of the eggs. *Aquaculture* 224: 323–338.

Pedersen, M. I. 2009. Does Stocking of Danish Lowland Streams with Elvers Increase European Eel Populations? American Fisheries Society Symposium 58: 149–156.

Pigliucci, M. 2003. Phenotypic integration: studying the ecology and evolution of complex phenotypes. *Ecology Letters* 6, 265–272.

Psuty I. and Draganik B. 2008. The effectiveness of glass eel stocking in the Vistula Lagoon, Poland. Acta Ichthyologica et Piscatoria, 38 (2): 103–111.

Psuty, I. 2009. Fishery in the transitional waters of the Polish part of the Vistula Lagoon - a review. Marine Pollution Bulletin (special issue) [accepted].

Pujolar, J.M., de Leo, G.A., Cicotti, E. and Zane, L. 2009. Genetic composition of Atlantic and Mediterranean recruits of European eel *Anguilla anguilla* based on EST-linked microsatellite loci. *Journal of Fish Biology* 74: 2034–2046.

Ricker. W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191.

Rockwell, LS., K.M.M.. Jones and D.K. Cone. 2009. First Record of *Anguillicoloides crassus* (Nematoda) in American Eels (*Anguilla rostrata*) in Canadian Estuaries, Cape Breton, Nova Scotia. Journal of Parasitology. 95(2): 483–486.

Roosens, L., Van Pelt, I., Geeraerts, C., Belpaire, C., Neels, H. and Covaci, A. In prep. PBDEs and HBCDs in Flemish eels: levels and isomeric patterns.

Rosell, R. S**.,** Evans, D, and Allen, M. 2005. The Eel fishery in Lough Neagh, Northern Ireland – An example of sustainable management? Fisheries Management and Ecology; 12, 377–385.

Satoh, H. 1979. Try for perfect culture of the Japanese eel. *Iden* 33, 23–30.

Simon, J. and Dörner, H. 2005. Marking the European eel with oxytetracycline, alizarin red and coded wire tags: an evaluation of methods. Journal of Fish Biology 67: 1486–1491.

Simon, J.; Dörner, H. and Richter, C. 2009. Growth and mortality of European glass eel *Anguilla anguilla* marked with oxytetracycline and alizarin red. Journal of Fish Biology 74: 289–295.

Sjöberg, N. B., Wickström, H. and Petersson, E. 2008. Bidrar den omflyttade ålen till lekbeståndet i Sargassohavet? -Blankålsmärkning kan ge svaret. Slutrapport från pilotprojekt till Fonden för fiskets utveckling Dnr: 231–0721–05, 43 (in Swedish).

Stouthart, X.J.H.X., Huijbregts, M.A.J., Balm, P.H.M., Lock, R.A.C. and Wendelaar Bonga, S.E. 1998. Endocrine stress response and abnormal development in carp (*Cyprinus carpio*) larvae after exposure of the embryos to PCB 126. Fish. Physiol. Biochem. 18, 321–329.

Tesch, F.W. (Thorpe, J.E., ed.). 2003. The eel, 5th ed. Blackwell Science, Oxford, England. 408 pp.

Tanaka, H., Kagawa, H. and Ohta, H. 2001. Production of leptocephali of Japanese eel (*Anguilla japonica*) in captivity. *Aquaculture* 201, 51–60.

Tanaka H. 2003. Techniques for larval rearing. In: Aida K, Tsukamoto K, Yamauchi K (eds) Eel biology. Springer- Verlag, Tokyo.

Tanaka, H., Kagawa, H., Ohta, H., Unuma, T., and Nomura, K. 2003. The first production of glass eel in captivity: fish reproductive physiology facilitates great progress in aquaculture. *Fish Physiology and Biochemistry* 28: 493–497.

Thomassen, S., Pedersen, M.I. and Holdensgaard, G. 2000. Tagging the European eel *Anguilla anguilla* (L.) with coded wire tags. *Aquaculture,* 185; 57–61.

Tomkiewicz, J. and Soerensen, R.S. 2009. Project Report: Artificial Reproduction of Eels III DTU Aqua Rapport.

Tsukamoto, K. 1992. Discovery of the spawning area for the Japanese eel. *Nature* 356, 789–791.

Tsukamoto, K. 2006. Spawning of eels near a seamount. Nature 439, 929.

Tsukamoto, K. 2009. Oceanic migration and spawning of Anguillid eels. *Journal of Fish Biology* 74, 1833–1852.

Tsukamoto, K., Otake, T., Mochioka, N., Lee, T.W., Fricke, H., Inagaki, T., Aoyama, J., Ishikawa, S., Kimura, S., Miller, M.J., Hasumoto, H., Oya, M. and Suzuki, Y. 2003. Seamounts, new moon and eel spawning: the search for the spawning site of the Japanese eel. *Environmental Biology of Fishes* 66, 221–229.

Tzeng, W.-N. 2009 a. Migratory behaviour and habitat use of Japanese eel in the estuary as revealed by both conventional mark-recapture method and otolith elemental signature. Summary presented at the ICES Saline SG.

Tzeng, W.-N. 2009 b. Naturally-recruited and restocked eels in Latvia: discrimination and growth comparison. Summary presented at the ICES Saline SG.

Usero, J., Izquierdo D., Morillo, J., and Gracia, I. 2003. Heavy metals in fish (*Solea vulgaris, Anguilla anguilla* and *Liza aurata*) from saltmarshes on the southern Atlantic coast of Spain. Environment International 29: 949–956.

van Ginneken, V.J.T. and van den Thillart, G.E.E.J.M. 2000. Eel fat stores are enough to reach the Sargasso. Nature 403: 156–157.

van Ginneken, V.J.T. and Maes, G.E. 2005. The European eel (*Anguilla anguilla*, Linnaeus), its life cycle, evolution and reproduction: a literature review. Reviews in Fish Biology and Fisheries 15: 367–398.

van Ginneken, V., Dufour, S., Sbaihi, M., Balm, P., Noorlander, K., de Bakker, M., Doornbos, J., Palstra, A., Antonissen, E., Mayer, I. and van den Thillart, G. 2007. Does a 5500 km swim trial stimulate early sexual maturation in the European eel (*Anguilla anguilla* L.)? Comparative Biochemistry and Physiology, in press, doi: 10.1016/j.cbpa.2007.03.021.

Van Leeuwen, S.P.J., Traag, W.A., Hoogenboom, L.A.P. and de Boer, J. 2002. Dioxins, furans, and dioxin-like PCBs in wild, farmed, imported and smoked eel from the Netherlands. RIVO Rapport C034/02.

van den Thillart, G.E.E.J.M., van Ginneken, V., Körner, F., Heijmans, R., Linden, R. and van der Gluvers, A. 2004. Endurance swimming of European eel. Journal of Fish Biology 65: 312–318.

van den Thillart, G.E.E.J.M., Palstra, A.P. and van Ginneken, V.J.T. 2007. Simulated migration of European silver eel: swim capacity and cost of transport. Journal of Marine Science and Technology 15 (special issue): 1–16.

Verreault, G., Dargere, W. and Tardif, R. 2009. American eel (*Anguilla rostrata*) movements, growth and sex ratio following translocation. American Fisheries Society Symposium 58: 129–136.

von Westernhagen *et al*. 2006. (Chlorinated hydrocarbons in North Sea whiting (*Merlangius merlangus* L.).

von Westernhagen H., Cameron, P., Dethlefsen, V., Janssen, D. 2006. Chlorinated hydrocarbons in North Sea whiting *(Merlangius merlangus* L.), and effects on reproduction. I. Tissue burden and hatching success. Helgolander Meeresunters. 43, 45–60.

Walker, M.K., Peterson, R.E. 1991. Potencies of polychlorinated dibenzo-p-dioxin, dibenzofuran, and biphenyl congeners, relative to 2, 3, 7, 8-tetrachlorodibenzo-pdioxin, for producing early life stage mortality in rainbow trout (*Oncorhynchus mykiss*). Aquat. Toxicol. 21, 219–238.

Walker, M.K., Cook, P.M., Batterman, A.R., Butterworth, B.C., Bernini, C., Libal, J.J., Hufnagle, L.C., and Peterson, R.E. 1994. Translocation of 2, 3, 7, 8-tetrachlorodibenzop-dioxin from adult female lake trout (*Salvelinus namaycush*) to oocytes—effects on early-life stage development and sac fry survival. Can. J. Fish Aquat. Sci. 51 (6), 1410–1419.

Wang, Y., Zhao, C. Shin, Z., Ten, Y., Zhang, K., Li, Y., Yang, Y. and Hong, Y. 1980. Studies on the artificial inducement of reproduction in common eel. Journal of Fisheries of China. 4, 147–158.

Wenner, C. A. 1973. Occurrence of American eels, *Anguilla rostrata*, in waters overlying the eastern North American continental shelf. Journal of the Fisheries Research Board of Canada 30, 1752–1755.

Westerberg, H., Ingvar Lagenfelt, I. and H. Svedäng. 2007. Silver eel migration behaviour in the Baltic. ICES Journal of Marine Science, 64: 1457–1462.

Wickström, H. 1986. Growth of cultured eels stocked in two Swedish lakes. Vie et Milieu Vol. 36:273–277.

Wickström, H., Westin, L. and Clevestam, P. 1996. The biological and economic yield from a long-term eel-stocking experiment. Ecology of Freshwater Fish. 5:140–147.

Wickström, H. 2001. Stocking as a Sustainable Measure to Enhance Eel Population. Unpublished doctoral thesis, Stockholm University, Stockholm, Sweden.

Wickström, H. and Clevestam, P. 2009. The unexpected lack of a freshwater origin in most silver eels leaving the Baltic Sea. Summary presented at the ICES Saline SG.

Williams, B. and Threader, R. 2007. A review of the proceedings and outcomes of the workshop on the American eel (*Anguilla rostrata*) stocking in Canadian waters. Montréal, Canada, March 26 and 27, 2007. 37p.

Wirth, T. and Bernhatchez, L. 2001. Genetic evidence against panmixia in the European eel. *Nature* 409: 1037–1040.

Yamamoto, K. and Yamauchi. 1974. Sexual maturation of Japanese eel and production of eel larvae in the aquarium. *Nature* 251: 220–222.

Annex 1: List of participants

NAME	ADDRESS	PHONE/FAX	EMAIL
Aprahamian, Miran	Environment Agency Richard Fairclough House Knutsford Road WA4 1HG Warrington UK	Phone +44 1925542713 Fax +44 1925415961	miran.aprahamian@environment-agency.gov.uk
Beaulaton, Laurent	ONEMA "Le Nadar" Hall C 5, square Félix Nadar 94300 Vincennes France	Phone +33 1 45 14 36 34 Mobile +33 6 81 47 52 71	Laurent.beaulaton@onema.fr
Belpaire, Claude	Instituut voor Natuur- en Bosonderzoek Duboislaan 14 1560 Hoeilaart Belgium	Phone +32 26580411 Fax +32 26579682 Mobile +32 475678992	Claude.Belpaire@inbo.be
Bevacqua, Daniele	Universita degli Studi di Parma Dipartimento di Scienze Ambientali Via Usberti 10A 143100 Parma Italy	Phone +39 3333024144 Fax +39 521905402	daniele.bevacqua@poste.it
Bodles, Kenneth	Queen's University Belfast School of Biology and Biochemistry 97 Lisburn Road BT9 7BL Belfast UK	Phone +44 Fax +44	Kbodles02@qub.ac.uk
Briand, Cedric	Institution d'Amenagement de la Viliane 56130 La Roche-Bernard France	Phone +33 99908844	cedric.briand@lavilaine.com
Cairns, David	Department of Fisheries and Oceans PO Box 1236 Charlottetown Prince Edward Island C1A 7M8 Canada	Phone +1 902 5667825 Fax +1 902 566-7848	David.Cairns@dfo-mpo.gc.ca
de Casamajor, Marie-Noelle	IFREMER 1 Alleé du Parc Montaury 64 600 Anglet France		Marie.Noelle.De.Casamajor@ifremer.fr

Name	Address	Phone/Fax	Email
Castelnaud, Gérard	CEMAGREF 50 Av. De Verdun, 33612 Cestas France	Phone +33 557890803 Fax +33 557890801	gerard.castelnaud@cemagref.fr
Ciccotti, Eleonora	Universita di Roma Tor Vergata Dipartimento di Biologia Via della Ricerca Scientifica 00133 Rome Italy	Phone +39 0672595969 Fax +39 0672595965	ciccotti@uniroma2.it
Dekker, Willem	Wageningen IMARES PO Box 68 NL-1970 AB IJmuiden Netherlands	Phone +31 317487164 Fax +31 317487326	Willem.Dekker@wur.nl
Diaz, Estibaliz	AZTI-Tecnalia AZTI Sukarrieta Txatxarramendi ugartea z/g 48395 Sukarrieta (Bizkaia) Spain	Phone +34 946 029 400 Fax +34 946 870 006	ediaz@azti.es
Dionne, Melanie	Ministere des Ressources naturelles et de la Faune du Québec Service de la Faune Aquatique 880, chemin Sainte-Foy Québec Québec G1S 4X4 Canada	Phone +1 418 627 8694 poste 7468 Fax +1 418 646 6863	melanie.dionne@mrnf.gouv.qc.ca
Domingos, Isabel	Instituto de Oceanografia, FCUL Campo Grande 1749-016 Lisbon Portugal	Phone +351 217500970 Fax +351 217500009	idomingos@fc.ul.pt
Evans, Derek	Agri-food and Biosciences Institute UK	Phone +44 2890255551	derek.evans@afbini.gov.uk
Godfrey, Jason	Marine Scotland Science Freshwater Laboratory Faskally Pitlochry PH16 5LB Scotland	Phone +44 1224 294444	j.d.godfrey@marlab.ac.uk
Hallett, Jason	University of New Brunswick Fredericton PO Box 5050 Fredericton NB E2L 4L5 Canada	Phone +1 Fax +1	Jason.hallett@unb.ca

Name	Address	Phone/Fax	Email
Hanel, Reinhold	Institute of Fisheries Ecology Federal Research Institute for rural Areas Forestry and Fisheries Palmaille 9 22767 Hamburg Germany	Phone +49 40 38905290	reinhold.hanel@vti.bund.de
Ingendahl, Detlev	Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen Wanderfischprogramm Heinsberger Str. 53 57399 Kirchhundem-Albaum Germany	Phone +49 272377940 Fax +49 272377577	detlev.ingendahl@lanuv.nrw.de
Jarvalt, Ain	Estonian University of Life Sciences Kreutzwaldi 64 EE-51014 Tartu Estonia	Phone +372 7454544 Fax +372 7454546	ain.jarvalt@emu.ee
Lambert, Patrick	CEMAGREF 50 Av. de Verdun 33612 Cestas France	Phone +33 557890809 Fax +33 557890801	patrick.lambert@cemagref.fr
McCarthy, Kieran	National University of Ireland University Road Co. Galway Ireland	Phone +353 91492333 Fax +353 91495426 Mobile +353 864018223	tk.mccarthy@nuigalway.ie
Nermer, Tomasz	Sea Fisheries Institute in Gdynia ul. Kollataja 1 81-332 Gdynia Poland	Phone +48-587356211 Fax +48 587356110	nermer@mir.gdynia.pl
Pedersen, Michael Ingemann	The National Institute of Aquatic Resources Department of Inland Fisheries Vejlsøvej 39 8600 Silkeborg Denmark	Phone +45 89213128	mip@aqua.dtu.dk
Poole, Russell Chair	Marine Institute Furnace Newport Co. Mayo Ireland	Phone + 353 98 42300 Fax +353 9842340	russell.poole@marine.ie
Psuty, Iwona	Sea Fisheries Institute in Gdynia ul. Kollataja 1 81-332 Gdynia Poland	Phone + 48587356218 Fax +48587356110	iwcia@mir.gdynia.pl

Name	Address	Phone/Fax	Email
Rosell, Robert	Agri-food and Biosciences Institute Newforge Lane BT9 5PX Belfast UK	Phone +44 2890255506 Fax +44 2890255004	robert.rosell@afbini.gov.uk
Simon, Janek	Institute of Inland Fisheries, Potsdam Im Königswald 2 14469 Potsdam Germany	Phone +49 33201 40620 Fax +49 33201 40640	janek.simon@ifb-potsdam.de
Thorstad, Eva	Norwegian Institute for Nature Research Tungasletta 2 7485 Trondheim Norway	Phone +47 73801400 (office) Fax +4773801401	eva.thorstad@nina.no
Verrault, Guy	Ministére des Ressources Naturelles et Faune 186 rue Fraser Rivière-du-Loup Qc Québec G5R 1C8 Canada	Phone +1 418 862 8213 ext. 306 Fax +1 418 862 8176	guy.verreault@mrnf.gouv.qc.ca
Walker, Alan M.	Centre for Environment Fisheries and Aquaculture Science Lowestoft Laboratory Pakefield Road NR33 0HT Lowestoft Suffolk UK	Phone +44 (0) 1502 524351 Fax +44 (0) 1502 526351	alan.walker@cefas.co.uk
Westerberg, Håkan	Swedish Board of Fisheries PO Box 421 40126 Göteburg Sweden	Phone +46 317430333 Fax +46 317430444	hakan.westerberg@fiskeriverket.se
Wickström, Håkan	Swedish Board of Fisheries Institute of Freshwater Research Stångholmsvägen 2 178 93 Drottningholm Sweden	Phone +46 86990607 Fax +46 86990650	hakan.wickstrom@fiskeriverket.se
Wysujack, Klaus	Johann Heinrich von Thünen-Institute Federal Research Institute for Rural Areas Forestry and Fisheries Institute for Fisheries Ecology Wulfsdorfer Weg 204 22926 Ahrensburg Germany	Phone: +49-4102-51128	klaus.wysujack@vti.bund.de

Annex 2: Agenda

Agenda for Joint EIFAC/ICES WGEEL 2009, Gothenburg, Sweden.

Mon 7th September

	9.00	Get organized
	9.30–10.00	Welcome RP
		Local Welcome and Information: Westerberg
	10.00–10.30	Intro to Working Group, ToR, etc. RP
	10.30	Coffee
	10.45–11.15	WKAREA report – introduced by Wickstrom/Poole
	11.15–11.45	SGAESAW report – introduced by Cairns
	11.45–12.15	EELIAD – update – introduced by Walker
	12.15–13.30	Lunch
	13.30–14.30	International Stock Assessment: intro by Dekker
	14.30–15.30	Data Group: introduced by Walker/Poole/Beaulaton
	15.30	Coffee
	16.00–16.30	Yellow Eel Assessments and Stocking updates: intro by Rosell.
	16.30–17.00	Upstream barriers and stock modelling: Verreault/Lambert
	17.00–17.30	Eel quality database and process update: Belpaire
	17.30–18.00	Update from N. America/Canada: introduced by Verreault
	until 18.00	Plenary of sub-Group leaders
Tues – Sub Groups breakout		
	13.15–14.00	Plenary
Wed – Sub Groups breakout		
	18.00	Plenary of sub-Group leaders
Thurs – morning - subgroups breakout		
	08.30–10.00	Plenary
	Afternoon	Draft conclusions and recommendations draft 1.
	15:30–18.00	Producing draft report [DEADLINE 18:00]
Fri	9.00–13:00	Circulate draft advice and report for comment
	14.00–18:00	Discuss and agree Report, and Recommendations and Draft technical advice
Sat	9.00–13:00	Discuss Report, and Recommendations
Conclude at 14.00		The afternoon is available to tie up loose ends.

Annex 3: Possible consequences of an assumption on no density-dependent effects on the recruit to spawner relationship during a period of falling recruitment

In the figures below, the dashed lines representing a possible form of density-dependence (DD) between recruitment and stock that may occur in nature whereas the solid lines represent the interpretation of these recruitment–stock relationships based on the hypothesis of an absence of density-dependence. These are shown for two time periods: before (red line) and after (blue line) management. In the short term the most likely recruitment trend in the appropriate period corresponding to current spawner output, so we consider a reduction of 50% in recruitment before and after management.

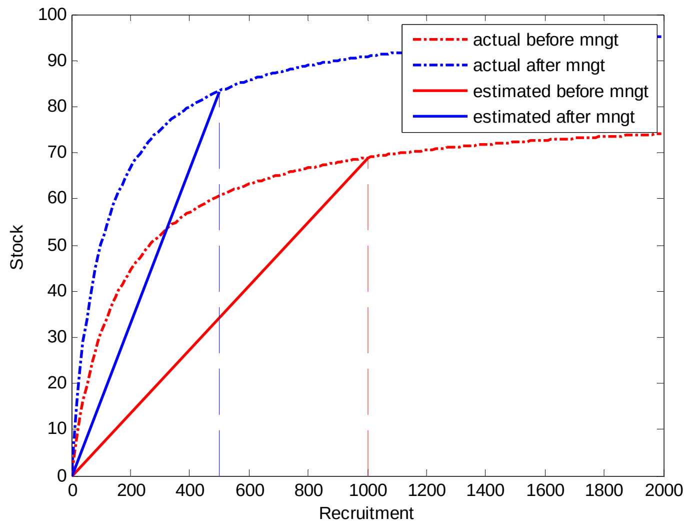


Figure 1: Possible recruitment to spawning stock relationships in the presence and absence of density-dependence, and their consequences for evaluating successful management measures, given a 50% decline in recruitment. Units are arbitrary.

In Figure 1 we show a situation where management has had a positive effect on spawner output (dashed blue line above dashed red line). Interpreting only the straight (non DD) lines, management actions are correctly interpreted to have caused a decrease in mortality and a genuine increase in spawner escapement (i.e. the solid blue line appears above the solid red line). However, using only the non DD lines we would estimate that management caused escapement to rise from 34 to 83 units, but in reality if density-dependence occurs as per the dotted lines, escapement would only have risen from 60 to 83. In this case the assumption of an absence of density-dependence is NOT PRECAUTIONARY, although such an assumption would have correctly have identified a qualitative positive impact of management.

Second we examine the situation where density-dependence exists and management measures in reality cause an *increase* in mortality (dashed blue line appears under dashed red line). (Figure 2).

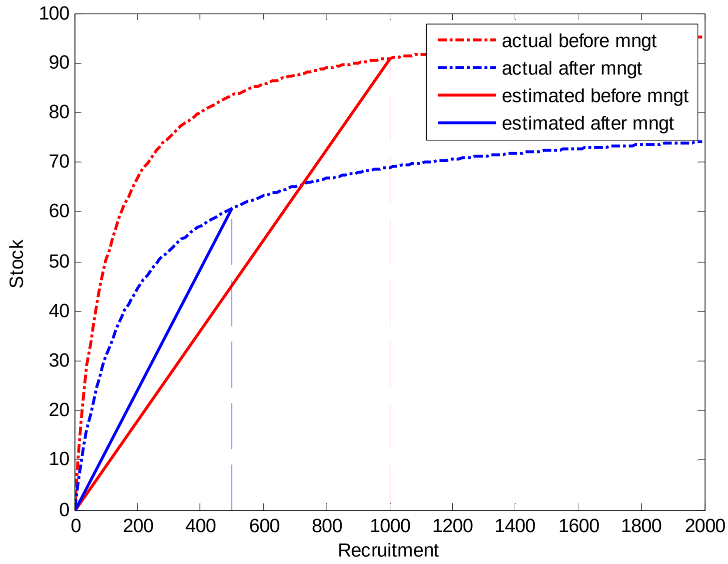


Figure 2: Possible recruitment to spawning stock relationships in the presence and absence of density-dependence, and their consequences for evaluating deleterious management measures, given a 50% decline in recruitment. Units are arbitrary.

In this case the assumption of an absence of density-dependence would lead us to conclude that escapement had risen from 45 to 60 units, whereas if density-dependence was present in the form depicted the true change in escapement would have been a fall from 83 to 60. In this case the assumption of an absence of density-dependence would have been CATASTROPHICALLY MISTAKEN, judging failing management measures to be having a positive effect.

However, the scale of the error in post-evaluation that occurs as a consequence of the assumption of an absence of density-dependence clearly depends on the scale of actual density-dependent effects. Given historically low recruitment levels of eels, and likely low population densities on the continent, it is probable that density-dependence is generally weak. In Figure 3 we examine a post-evaluation of management measures identical with that shown in Figure 2, but in the zone where the S=f(R) relationship can be approximated by a straight line. Here the qualitative evaluation of the efficacy of the management measures is correctly identified as negative, though quantitatively their deleterious impact is underestimated (a fall from 23 to 18 units, where in reality the fall was from 33 to 18 units.

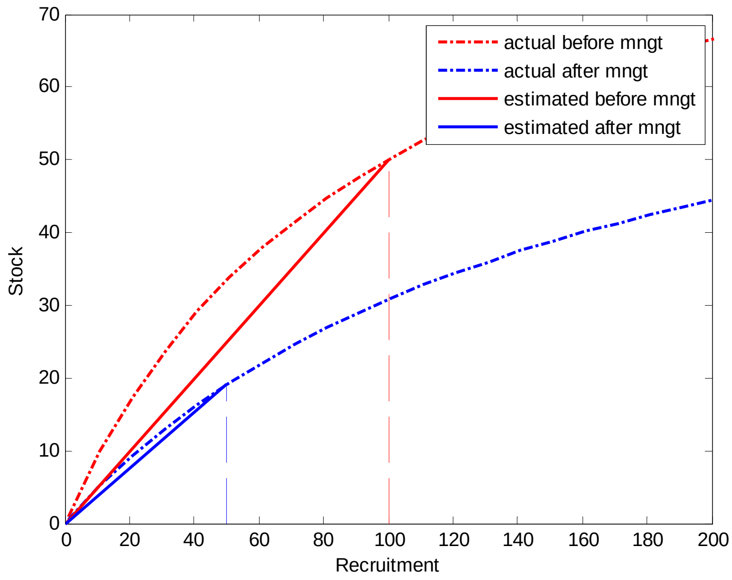


Figure 3: Possible recruitment to spawning stock relationships in the absence of density-dependence, and in the presence of weak density-dependence, and their consequences for evaluating deleterious management measures, given a 50% decline in recruitment. Units are arbitrary.

Annex 4: Draft WGEEL Terms of Reference 2010

2009/2/ACOM18 The **Joint EIFAC/ICES Working Group on Eels** [WGEEL] (Chair: Russell Poole), will meet in Hamburg, Germany, 9–14 September 2010, to:

a) assess the trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;

a) develop methods to post-evaluate effects of management actions at the stock-wide level (in conjunction with SGIPEE);

b) develop methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures (in conjunction with SGAESAW 2);

c) provide practical advice on the establishment of international databases on eel stock, fisheries and other anthropogenic impacts, as well as habitat and eel quality related data, and the review and development of recommendations on inclusion of data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, on stock assessment methods;

d) review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these into stock assessments;

e) respond to specific requests in support of the eel stock recovery Regulation, as necessary; and

f) report on improvements to the scientific basis for advice on the management of European and American eel.

WGEEL will report by XX September 2010 for the attention of WGRECORDS, SGEF and ACOM.

Annex 5: Draft SGIPEE Terms of Reference 2010

2009/2/SSGEF20 The **Study Group on International Post-Evaluation on Eels** (SGIPEE), chaired by Laurent Beaulaton*, France, will be established and will meet in Vincennes, France, XX 2010 [to be announced] and in 2011 [to be announced] to:

a) Review stock assessment and post-evaluation methods available for species of eels, and those used by ICES Expert Groups on other species, that could be successfully applied to eels at the stock-wide level in 2012;

b) Adapt methods for stock-wide post-evaluation of Anguilla anguilla and apply them to data collated by WGEEL at its annual meetings; (this may include aggregation of EMU post-evaluation);

c) Analyze sensitivity of the selected methods to stock improvement or deterioration using simulated data; and

d) Submit recommendations to WGEEL on: the best available post-evaluation method for 2012; gaps in data or knowledge that need to be filled before 2012; and methods that should be developed and data that should be collected after 2012 for the next stock-wide evaluation.

SGIPEE will report by 1 September 2010 and 2011 (via SSGEF) for the attention of WGEEL, WGRECORDS and SCICOM.

Supporting Information

Priority	Evaluating the status of the stock and post-evaluating the effect of management plans at the European level should be of the uttermost priority. An urgent requirement to prepare for EU 2012 reporting.
Scientific justification	European and American eel stocks are currently in a severely depleted state. ICES has proposed that biological reference points for eels could be derived from spawner-per-recruit (SPR) analysis and the EU Regulation for the Recovery of the Eel Stock requires biomass estimates of current silver eel escapement. So far the difficulty of having many different independent parts of the stock isolated in different river basins and areas with varying anthropogenic impacts, and levels of information has hampered the achievement of a stock-wide analysis of the stock and precluded fully informed analyses of the stock-recruitment and recruitment-stock relationships. Nevertheless, the attempts made so far to estimate the restoration time and to calibrate required management actions are alarming and highlight the necessity of better knowing the stock status, and threats posed by density-dependent (depensatory, compensatory) mechanisms. Management plans when put into action should bring a wealth of new data, which will fail to produce a clear picture of the stock if they lack the structure and coordination required for a stock wide assessment. However, if collected correctly and used judiciously they could be used to enhance the current knowledge of stock status, and provide a European overview of current mortalities and biomass levels. Analyses, development and testing of the methods, and their dependence on data, will help to build a consistent pan-European post evaluation tool, leading in turn to calibrate future measures. It is highly likely that ICES will be requested to undertake the evaluation of the outcome of the Regulation following Member State reporting in 2012 and 2015. It is beyond the capacity of the WGEEL in its annual meetings to develop this capacity and WGEEL strongly recommend the formation of the SG. DGMARE have funded a pilot study to estimate silver eel biomass at the local level but neglected to include a stock-wide post-evaluation mechanism in the project. This SG is aimed at filling this gap.
Resource requirements	
Participants	Members of WGEEL and invited experts from areas of the North Atlantic and elsewhere with eel populations.
Secretariat facilities	A centralized database should help the achievement of international post-evaluation
Financial	
Linkages to advisory committees	The proposal is of direct relevance to ACOM in relation to the development of appropriate assessment methods for eel.
Linkages to other committees or groups	WGEEL, WGRECORDS, SCICOM , other Working Groups on inshore fisheries.
Linkages to other organizations	EU FP7 EELIAD, European Union Recovery Plans; DGMARE pilot project on estimating silver eel escapement; Canadian Eel Science Working Group, U.S. Atlantic States Marine Fisheries Commission Eel Technical Committee

Annex 6: Draft SGAESAW Terms of Reference 2010

2009/2/SSGEF22 **The Study Group on Anguillid Eels in Saline Waters** (SGAESAW), chaired by [to be announced] will meet in VENUE, DATE [to be announced] to:

a) Extract and examine eel data from general fish stock surveys in open marine waters;

b) Review and develop local stock assessment methods in anguillid eels in saline waters with reference to habitat use, demographic characteristics and sampling techniques and in comparison with these features in fresh waters;

c) Make recommendations on the use of habitat-specific demographic characteristics in population models (e.g. SPR, biomass targets, silver eel escapement rates), and on overall conservation approaches that embrace salinity-based differences;

d) Define research and analytic approaches for anguillid eels in saline waters that will advance progress towards constructing robust stock-wide management models.

SGAESAW will report by 31 December 2010 (via SSGEF) for the attention of WGEEL, SGIPEE, ACOM, WGRECORDS and SCICOM.

Supporting Information

Priority	The work of the Group is essential if ICES is to be appropriately placed to advise on the development of recovery plans for eels in Europe and North America, and particularly the Eel Management Plans required under EU Regulation 1100/2007.
Scientific justification	European and American eel stocks are currently in a severely depleted state. ICES has proposed that biological reference points for eels could be derived from spawner-per-recruit (SPR) analysis and the EU Regulation for the Recovery of the Eel Stock requires biomass estimates of current silver eel escapement. For this approach to provide meaningful results at the local and stock (species) scale, biologists need to know the relative importance of the habitat types used by eels and what demographic characteristics they exhibit in these habitats. One key habitat distinction is between fresh and saline (brackish/salt) waters. While recent research has increasingly revealed the importance of brackish and sheltered salt water habitats for eel, little remains known about eels in estuarine and particularly coastal waters, and most assessments currenly take little or no account of the importance of these habitats in the production of potential spawners. The Study Group will inform the future development of assessment methods. A major gap identified by SGAESAW 2009 was the lack integrated assessment methods to determine the density and biomass of the local stocks.
Resource requirements	None.
Participants	Members of WGEEL and invited experts from areas of the North Atlantic and elsewhere with eel populations.
Secretariat facilities	None.
Financial:	Covering the expenses of travel & meetings would be appropriate
Linkages to advisory committees	The group is of direct relevance to ACOM in relation to the development of appropriate assessment methods for eel.
Linkages to other committees or groups	WGEEL, SGIPEE and SCICOM, other Working Groups on inshore fisheries, Canadian Eel Science Working Group, U.S. Atlantic States Marine Fisheries Commission Eel Technical Committee
Linkages to other organizations	Institutes participating in EU FP7 EELIAD, Organsiations developing EU Eel Management Plans, DGMARE Pilot study on estimating silver eel biomass

Annex 7: Draft WKAREA 2 Terms of Reference 2010

The **Workshop on Age Reading of European and American Eel** [WKAREA-2] (Chair: Françoise Daverat, France) will exchange information by correspondence in 2010 and meet in Bordeaux, France in March 2011 to:

a) to exchange samples (>100 per species) of European and American eel otolith pictures, including known age eels, with samples prepared using different protocols and representing a range of eel subpopulations, and environment types encountered in both species range;

b) to apply the age estimation criteria defined during the previous meeting in an inter-calibration process involving the exchanged images and a significant number of readers (>20);

c) to analyse readings and interpret the results of the inter-calibration of European and American eel age reading;

d) to make recommendations and feed back on the age estimation criteria to increase age estimation precision and accuracy and improve the inter reader agreement; and

e) to incorporate the findings with the report and manual developed by WKAREA 2009 for formal publication.

WKAREA-2 will report by 1 May 2011 for the attention of WGRECORDS, WGEEL, SGEF and PGCCDBS.

Supporting Information

Priority:	The work of the Group is essential if ICES is to be appropriately placed to advise on the development of recovery plans for eels. This is integral to the ability of institutes to support the delivery of ageing data under the DCR.
Scientific justification and relation to action plan:	European and American eel stocks are currently in a severely depleted state. ICES has proposed that biological reference points for eels could be derived from spawner-per-recruit (SPR) analysis and the EU Regulation for the Recovery of the Eel Stock requires biomass estimates of current silver eel escapement. For this approach to provide meaningful results at the local and stock (species) scale, biologists need to estimate eel age with precision. The previous meeting (WKAREA) setup a process for otolith preparation, image exchange, established age estimation criteria for European and American eel and printed a manual of eel age determination and images. A small scale age intercalibration was conducted during the meeting based on known age eel samples. This exercise pointed out the need for a larger scale age intercalibration reading in order to apply the newly established age estimation criteria, and to measure the accuracy and precision of readers.
Resource requirements:	No specific resource requirements beyond the need for members to prepare for and participate in the meeting.
Participants:	Members of WGEEL and invited experts from areas of the North Atlantic and elsewhere with eel populations.
Secretariat facilities:	No additional software/hardware is anticipated beyond that which is currently available.
Financial:	Covering the expenses of travel & meetings would be appropriate
Linkages to advisory committees:	Links to ACOM relate to the development of appropriate assessment methods for eel.
Linkages to other committees or groups:	WGEEL, WGRECORDS, SCICOM , other Working Groups on inshore fisheries, Canadian Eel Science Working Group, U.S. Atlantic States Marine Fisheries Commission Eel Technical Committee
Linkages to other organizations:	EU FP7 EELIAD, European Union Recovery Plans

Annex 8: Tables pertaining to Section 2

Table 2.1: GLM estimates of the level of recruitment (mean values per area).

year	glass eel Atlantic Oc	glass eel British Isle	glass eel Mediterran	glass eel North sea	yellow eel Baltic	yellow eel North sea
1950	0.4		1.42	1.19	3.72	4.16
1951	0.78		0.78	1.27	18.85	1.99
1952	0.57			4.81	12.95	3.58
1953	0.7		0.94	4.08	19.1	6.44
1954	0.48		2.19	6.61	11.82	2.29
1955	0.88		0.34	6.3	17.41	3.76
1956	1		0.33	4.83	4.96	2.74
1957	0.88		1.05	2.63	6.8	2.75
1958	0.97		0.15	4.58	4.71	3.39
1959	0.85	0.12	2.46	6.2	17.88	4.81
1960	1.57	1.36	3.51	7.61	5.47	3.73
1961	0.9	0.86	6.21	4.77	7.87	2.69
1962	2.1	1.58	4.11	8.38	7.89	2.57
1963	3.32	1.39	2.97	11.33	6.61	2.2
1964	0.87	0.5	4.08	4.72	2.63	0.84
1965	2.64	0.76	1.48	3.65	5.27	1.48
1966	0.94	1.23	1.79	3.44	7.76	1.97
1967	1.41	0.34	1.64	3.95	5.05	1.28
1968	2.56	0.73	2.03	4.82	4.08	4.12
1969	1.09	0.21	1.11	3.39	4.13	2.04
1970	1.89	0.72	1.35	4.13	1.43	1.23
1971	1.02	0.71	0.48	2.47	2.35	1.04
1972	1.01	0.8	0.37	3.72	1.43	3.49
1973	1.11	1.01	0.35	2.01	2.92	3.27
1974	1.59	1.58	0.57	4.9	0.87	1.74
1975	1.01	0.67	1.71	2.36	2.38	3.11
1976	2.1	0.55	2.11	4.19	1.04	1.37
1977	1.76	1.23	2.02	4.14	3.09	1.4
1978	2.14	1.51	1.16	3.27	2.04	1.24
1979	2.08	2.69	2.15	3.77	0.96	1.22
1980	1.88	1.96	2.02	2.75	0.7	2.67
1981	1.38	1.66	1.29	2.24	0.48	1.01
1982	1.68	2.06	0.92	1.29	0.64	1.63
1983	1.06	0.43	0.8	1.22	1.72	0.82
1984	1.16	0.72	0.71	0.41	1.24	0.54
1985	0.96	0.65	0.86	0.52	1.15	1.32
1986	0.68	0.7	0.1	0.49	1.24	0.7
1987	0.86	1.04	1.33	0.58	1.58	0.84
1988	0.72	0.82	2.18	0.36	2.2	1.11
1989	0.69	0.55	1.21	0.18	0.4	0.82
1990	0.45	0.77	0.71	0.55	0.59	0.93
1991	0.35	0.17	0.32	0.1	0.96	0.73
1992	0.49	0.35	0.21	0.26	0.51	0.4
1993	0.56	0.45	0.19	0.26	0.63	0.25
1994	0.43	0.81	0.14	0.37	3.29	0.38
1995	0.64	0.66	0.09	0.3	0.39	0.2
1996	0.5	0.65	0.11	0.24	0.39	0.15
1997	0.55	0.95	0.15	0.22	0.66	0.35
1998	0.28	0.44	0.27	0.13	0.24	0.33
1999	0.46	0.39	0.15	0.25	0.76	0.35
2000	0.45	0.24	0.07	0.22	0.93	0.17
2001	0.14	0.13	0.21	0.04	0.88	0.21
2002	0.25	0.18	0.21	0.12	1.6	0.58
2003	0.13	0.31	0.19	0.11	0.85	0.29
2004	0.13	0.15	0.09	0.03	1.97	0.17
2005	0.17	0.21	0.07	0.07	0.27	0.11
2006	0.12	0.11	0.11	0.02	0.92	0.1
2007	0.11	0.09	0.14	0.07	1.16	0.33
2008	0.13	0.02	0.07	0.03	0.24	0.13
2009	0.1	0.02	0.06	0.02		0.46[1]

[1] One series (Imsa) only for 2009

Table 2.2: Recruitment raw data.

These data remain the property of the Country of origin and should not be used without the permission of the data provider. Contact the Country Report Author for permission before using for analysis.

Year	North sea, Sweden, Index: IYFS scientific estimate (Glass eel)	North sea, Sweden, Index: IYFS2 scientific estimate (Glass eel)	North sea, Sweden, Kg: Ringhals scientific survey (Glass eel)	North sea, Sweden, Kg: Viskan Sluices trapping all (Glass eel)	British Isle, Northern Ireland, Kg: Bann Coleraine trapping partial (Glass eel)	British Isle, Northern Ireland, Kg: Erne Ballyshannon trapping all (Glass eel)	British Isle, Ireland, Kg: Shannon Ardnacrusha trapping all (Glass eel)	Atlantic Ocean, Ireland, Kg: River Feale (Glass eel)	Atlantic Ocean, Ireland, Kg: River Maigue (Glass eel)	Atlantic Ocean, Ireland, Kg: River Inagh (Glass eel)
1960	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1965	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1966	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1968	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1969	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1970	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1972	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1973	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1974	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1975	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1976	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1977	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1978	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1979	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1980	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1981	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1982	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1983	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1984	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1985	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1996	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1997	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1998	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1999	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2007	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2008	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2009	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Year	British Isle, UK, Kg: Severn EA commercial catch reports (Glass eel)	British Isle, UK, Kg: Severn HMRC nett trade export (Glass eel)	North sea, Denmark, Kg: Vidaa Højer sluice commercial catch (Glass eel)	North sea, Germany, Kg: Ems Herbrum commercial catch (Glass eel)	North sea, Netherlands, Index: Lauwersoog scientific estimate (Glass eel)	North sea, Netherlands, Index: Rhine DenOever scientific estimate (Glass eel)	North sea, Netherlands, Index: Rhine Ijmuiden scientific estimate (Glass eel)	North sea, Netherlands, Index: Katwijk scientific estimate (Glass eel)	North sea, Netherlands, Index: Stellendam scientific estimate (Glass eel)	North sea, Belgium, Kg: Ijzer Nieuwpoort scientific estimate (Glass eel)	Atlantic Ocean, France, Kg: Vilaine Arzal trapping all (Glass eel)	Atlantic Ocean, France, Kg: Loire Estuary commercial catch (Glass eel)	Atlantic Ocean, France, cpue: Sèvres Niortaise Estuary commercial CPUE (Glass eel)	Atlantic Ocean, France, t: Gironde Estuary (catch) commercial catch (Glass eel)	Atlantic Ocean, France, cpue: Gironde Estuary (CPUE) commercial CPUE (Glass eel)	Atlantic Ocean, France, Index: Gironde scientific estimate (Glass eel)	Atlantic Ocean, France, t: Adour Estuary (catch) commercial catch (Glass eel)	Atlantic Ocean, France, cpue: Adour Estuary (CPUE) commercial CPUE (Glass eel)	Atlantic Ocean, Spain, Kg: Ion Estuary commercial catch (Glass eel)
1900																			
1901																			
1902																			
1903																			
1904																			
1905																			
1906																			
1907																			
1911																			
1912																			
1913																			
1914																			
1919																			
1920																			
1921																			
1922																			
1923														46.00					
1924												65.00							
1925												70.00							
1926												90.00		18.70					
1927												65.00		34.10					
1928												102.00		22.40				5.00	
1929														22.50				5.50	
1930												1.00		28.20				6.70	
1931														26.90				18.70	
1932														31.10					
1933														13.50					
1934												90.00		13.40					
1935												150.00		19.70					
1936												30.00							
1937												7.00							
1938						21.63						15.00							
1939						48.53						17.00							
1940						18.19						27.00							
1941						15.79						21.00							
1942						25.52													
1943						16.71													
1944						48.72						10.00							
1945						19.78						66.00							
1946				600.00		8.03						43.00							
1947				1438.00		7.89						178.00							
1948				1640.00		6.82						197.00							
1949				1182.00		6.72						193.00							
1950				875.00		8.71						86.00							
1951				719.00		17.77						166.00							
1952				1516.00		113.86						121.00							
1953				3275.00		18.82						91.00							14529.00
1954				5369.00		28.15						86.00							8318.00
1955				4795.00		38.94						181.00							13576.00
1956				4194.00		10.22						187.00							16649.00
1957				1829.00		22.79						168.00							14351.00
1958				2263.00		74.50						230.00							12911.00
1959				4654.00		40.83						174.00							13071.00
1960				6215.00		30.95						411.00							17975.00
1961				2995.00		53.17						334.00		32.17	10.47				13060.00
1962				4430.00		124.33						185.00	30.00	217.82	30.64				17177.00
1963				5746.00		178.02						116.00	72.00	362.99	33.15				11507.00
1964				5054.00		55.50				3.70		142.00							16139.00
1965				1363.00		115.22				115.00		134.00	17.00	352.52	62.74				20364.00
1966				1840.00		27.71				385.00		253.00	13.00	27.62	10.02			5.10	11974.00
1967				1071.00		42.33				575.00		258.00	8.00	162.79	25.46			6.40	12977.00
1968				2760.00		28.91				553.50		712.00	15.00	284.20	38.23			10.10	20556.00
1969				1687.00		24.82	47.30			445.00		225.00	14.00	36.62	18.52			5.00	15628.00
1970				683.00		56.64	31.50			795.00		453.00	15.00	203.75	24.98			7.50	18753.00
1971			787.00	1684.00		25.01			15.00	399.00	44.00	330.00	12.00	47.07	9.12			4.60	17032.00
1972	16.70		780.00	3894.00		44.78			4.00	556.50	38.00	311.00	11.00	69.00	13.73			4.40	11219.00
1973	28.20		641.00	289.00		32.03	32.80		13.00	354.00	78.00	292.00	8.50	20.04	29.19			4.50	11056.00
1974	57.50		464.00	4129.00		37.26	119.30		23.00	946.00	107.00	557.00	9.00	54.56	21.44			7.40	24481.00
1975	10.50		888.00	1031.00		48.44	66.80		14.00	274.00	44.00	497.00	8.50	44.10	12.50			5.00	32611.00
1976	13.10		828.00	4205.00	14.40	39.63	73.10		11.00	496.00	106.00	770.00	17.00	120.90	34.00			11.00	55514.00
1977	38.60		91.00	2172.00	28.40	88.85	159.20	130.25	42.00	472.00	52.00	677.00	15.00	121.64	25.38				37661.00
1978	61.20		335.00	2024.00	83.90	56.32	131.70	30.23	42.00	370.00	106.00	526.00	18.00	64.67	23.17				59918.00
1979	67.00	40.10	220.00	2774.00	66.20	78.36	176.00	3.23	27.00	530.00	209.00	642.00	17.50	73.20	18.74			10.00	37468.00
1980	40.10	32.80	220.00	3195.00	80.30	39.66	101.50	171.60	45.00	252.00	95.00	526.00	12.00	124.69	35.05			5.00	42110.00
1981	36.90		226.00	962.00	55.10	33.32	113.90	31.65	47.00	90.00	57.00	303.00	9.00	84.91	32.41				34645.00
1982	48.00	30.40	490.00	674.00	17.40	21.01	20.80	4.13	11.00	129.00	98.00	274.00	8.50	61.01	14.55				26295.00
1983	16.90	6.20	662.00	92.00	15.10	14.07	15.60	2.10	14.00	25.00	69.00	260.00	6.00	66.71	14.33				21837.00
1984	25.00	29.00	123.00	352.00	7.10	18.80	11.40	23.62	4.00	6.00	36.00	183.00		45.02	13.87				22541.00
1985	20.00	18.60	13.00	260.00	25.20	19.41	1.00	6.67	9.00	15.00	41.00	154.00		26.98	7.39			2.40	12839.00
1986	19.00	15.50	123.00	89.00	1.30	20.56	4.70		6.00	27.50	52.60	123.00		35.31	9.02		8.00	1.50	13544.00
1987	21.30	17.70	341.00	8.00	52.00	7.96	7.70	14.00	10.00	36.50	41.20	145.00		44.64	9.00		9.50	3.30	23536.00
1988	21.40	23.10	141.00	67.00	0.50	5.91	3.50		8.00	48.20	46.60	177.00		27.90	7.55		12.00	3.70	15211.00
1989	20.60	13.50	9.00	13.00	12.10	4.10	1.60	3.67	4.00	9.10	36.70	87.00		45.94	8.90		9.00	4.10	13574.00
1990	20.90	16.00	5.00	99.00	5.00	4.88	4.70		11.00	218.20	35.90	96.00		29.27	5.37		3.20	1.20	9216.00
1991	1.10	7.80		52.00	6.30	1.47	2.00	5.10	2.00	13.00	15.35	36.00		38.37	6.78		1.50	0.70	7117.00
1992	5.00	17.70		6.00	7.30	3.94	2.50	8.20	10.00	18.90	29.57	39.00		22.51	6.58	1.75	8.00	2.90	10259.00
1993	5.73	20.90		20.00	20.80	3.95	1.60	13.50	5.00	11.80	31.00	91.00		42.40	8.92	2.83	5.50	2.40	9673.00
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1996	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1997	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1998	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1999	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2007	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2008	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2009	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Year	Mediterranean, Spain, Kg: Albufera de Valencia commercial catch (Glass eel)	Atlantic Ocean, Spain, Kg: Minho spanish part commercial catch (Glass eel)	Atlantic Ocean, Portugal, Kg: Minho portugese part commercial catch (Glass eel)	Mediterranean, Spain, Kg: Ebro delta lagoons (Glass eel)	Mediterranean, Spain, cpue: Albufera de Valencia commercial CPUE (Glass eel)	Mediterranean, Italy, t: Tiber Fiumara Grande commercial catch (Glass eel)	North sea, Norway, Number: Imsa Near Sandnes trapping all (Yellow eel)	Baltic, Sweden, Kg: Dalälven trapping all (Yellow eel)	Baltic, Sweden, Kg: Motala Ström trapping all (Yellow eel)	Baltic, Sweden, Kg: Mörrumsån trapping all (Yellow eel)	Baltic, Sweden, Kg: Kävlingeån trapping all (Yellow eel)	North sea, Sweden, Kg: Rönne Å trapping all (Yellow eel)	North sea, Sweden, Kg: Lagan trapping all (Yellow eel)	North sea, Sweden, Kg: Göta Älv trapping all (Yellow eel)	British Isle, Ireland, Kg: Shannon Parteen trapping partial (Yellow eel)	North sea, Denmark, Kg: Guden Å Tange trapping all (Yellow eel)	North sea, Denmark, Kg: Harte trapping all (Yellow eel)	North sea, Belgium, Kg: Meuse Lixhe dam trapping partial (Yellow eel)
1900														530.00				
1901														5100.00				
1902														340.00				
1903														858.00				
1904														552.00				
1905														8700.00				
1906														2000.00				
1907														275.00				
1911														5728.00				
1912														6529.00				
1913														20.00				
1914														2828.00				
1919														1465.00				
1920														800.00				
1921														1555.00				
1922														455.00				
1923														1732.00				
1924														4551.00				
1925													331.30	5463.00				
1926													357.80	3893.00				
1927													581.10	4796.00				
1928													211.90	47.00				
1929													4.50	756.00				
1930													268.00	5753.00				
1931													316.00	2103.00				
1932													408.00	7238.00				
1933													303.50	6333.00				
1934													236.00	6338.00				
1935													53.50	1336.00				
1936													24.50	2537.00				
1937													0.50	8711.00				
1938													106.50	3879.00				
1939													36.00	4775.00				
1940													684.00	1894.00				
1941													321.00	2846.00				
1942									14.00				454.00	427.00				
1943									283.00				1248.00	1848.00				
1944									773.00				1090.00	2342.00				
1945									406.00				1143.00	2636.00				
1946									280.00			29.70	766.50	2452.00				
1947									272.50			5.80	440.80	675.00				
1948									120.00			6.00	494.70	1702.00				
1949	9319.00								43.00			39.40	603.60	1711.00				
1950	3828.00								304.50			93.50	419.90	2947.00				
1951	2093.00							210.00	2713.00			1.00	281.80	1744.00				
1952								324.00	1543.50			9.10	379.10	3662.00				
1953	2535.00							241.50	2698.00			70.00	802.40	5071.00				
1954	5910.00							508.50	1030.00			2.70	511.30	1031.00				
1955	906.00							550.00	1871.00			42.60	506.90	2732.00				
1956	884.00							215.00	429.00			14.10	501.60	1622.00				
1957	2833.00							161.50	826.00			46.80	336.10	1915.00				
1958	402.00							336.70	172.00			73.20	497.20	1675.00				
1959	6637.00							612.60	1837.00			80.00	910.50	1745.00				
1960	9453.00							289.00	799.00	29.00		93.00	552.40	1605.00				
1961	16731.00							303.00	706.00	665.50		143.70	314.80	269.00				
1962	11088.00							289.00	870.00	534.80		113.00	261.90	873.00				
1963	7997.00							445.40	581.00	241.20		32.50	298.10	1469.00				
1964	11000.00							158.00	181.60	177.80		34.70	27.50	622.00				
1965	4000.00							276.40	500.00	292.30		87.10	28.00	746.00				
1966	6000.00			4651.00				157.50	1423.00	196.30		48.50	216.50	1232.00				
1967	5000.00			4937.00				331.80	283.00	353.60		6.60	24.40	493.00			500.00	
1968	4000.00			8858.00				265.50	184.00	334.80		398.00	74.40	849.00			200.00	
1969	4000.00			2524.00				333.70	135.00	276.80		85.70	117.10	1595.00			175.00	
1970	5000.00			2947.00				149.80	2.00	80.40		29.80	24.70	1046.00			235.00	
1971	1000.00			2022.00				242.00	1.00	141.10		53.30	45.30	842.00			59.00	
1972	1000.00			1261.00				87.60	51.00	139.90		249.00	106.20	810.00				
1973	1000.00			1129.00				159.70	46.00	375.00		282.30	107.10	1179.00			117.00	
1974	2000.00			1354.00				49.50	58.50	65.40		120.70	33.60	631.00			212.00	
1975	1000.00	1600.00	50.00	2466.00		11.00	42945	148.70	224.00	93.30		206.70	78.40	1230.00			325.00	
1976	6000.00	5600.00	5000.00	5626.00		6.70	48615	44.00	24.00	147.20		17.10	20.20	798.00			91.00	
1977	5000.00	12500.00	7500.00			5.90	28518	176.40	353.00	89.60		32.10	26.40	256.00			386.00	
1978		21600.00	15000.00	3400.00		3.60	12181	35.10	266.00	168.40		10.80	75.80	873.00			334.00	
1979		17300.00	7000.00	4177.00		8.40	2457	34.30	112.00	61.40		56.10	165.90	190.00			291.00	
1980		15400.00	13000.00	3514.00		8.20	34776	71.20	7.00	36.50		165.70	226.00	906.00		93.00	522.00	
1981		13000.00	3000.00	3800.00		4.00	15477	6.80	31.00	72.80		49.20	78.00	40.00		187.00	279.00	
1982	1309.00	18000.00	32000.00	2636.00	18.44	4.00	45750	0.50	22.00	129.00		40.00	90.80	882.00		257.00	239.00	
1983	640.00	9700.00	6700.00	2327.00		4.00	14500	112.10	12.00	204.60		37.60	87.80	113.00		146.00	164.00	
1984	2387.00	14000.00	16000.00	1815.00	14.83	1.80	6640	33.90	48.00	189.90		0.50	68.00	325.00		84.00	172.00	
1985	2980.00	15300.00	14800.00	1690.00	17.32	2.50	3412	69.70	15.20	138.10			234.10	77.00	984.00	315.00	446.00	
1986	402.00	6000.00	7000.00	301.00		0.20	5145	28.40	26.00	220.30		8.60	2.50	143.00	1555.00	676.00	260.00	
1987	2845.00	6539.00	9500.00	2027.00	17.89	7.40	3434	73.50	201.00	54.50		84.80	69.80	168.00	984.00	145.00	105.00	
1988	4255.00	5600.00	2600.00		21.17	10.50	17500	69.00	169.50	241.00		4.90	191.70	475.00	1265.00	252.00	253.00	
1989	2513.00	7359.00	3000.00		12.76	5.50	10000		35.20	30.00			44.00	598.00	581.00	354.00	145.00	
1990	1321.00	3962.00	4500.00	1108.00	7.69	4.40	32500		21.00	72.50		32.00	21.60	149.00	970.00	367.00	101.00	
1991	1079.00	5743.00	2500.00	897.00		0.80	6250		2.00	151.00			161.30	264.00	372.00	434.00	44.00	
1992	831.00	2835.00	4500.00	323.00		0.60	4450	9.60	108.00	14.00	12.50		42.20	404.00	464.00	53.00	40.00	5613.00
1993	355.00	4893.00	3600.00	799.00	4.23	0.50	8625	6.60	89.00	45.70	25.80		8.70	64.00	602.00	93.00	26.00	
1994	302.00	2068.00	2900.00	350.00	3.26	0.50	525	71.90	650.00	283.00	4.00		30.70	377.00	125.00	312.00	35.00	
1995	199.00	4701.00	5300.00	190.00	2.31	0.30	1950	7.60	32.00	72.40	2.90		11.60		799.00	83.00	23.00	4240.00
1996	271.00	6523.00	8700.00	409.00	3.57	0.10	1000	17.50	14.00	51.90	13.50		2.80	277.00	95.00	56.00	6.00	
1997	366.00	4283.00	4400.00	847.00	3.42	0.10	5500	7.50	8.10	148.00	19.40	10.40	31.70	180.00	906.00	390.00	9.00	2706.00
1998	1348.00	2878.00	4500.00	939.00		0.13	1750	14.70	5.50	12.90	15.30	24.00	62.60		255.00	29.00	18.00	3061.00
1999	616.00	3812.00	3600.00	465.00	4.16	0.06	3750	15.50	85.00	84.20	22.20	4.20	49.50		701.00	346.00	15.00	4664.00
2000	323.00	3812.00	3000.00	112.00	1.90	0.07	1625	12.40	270.10	1.00	5.00		13.00		389.00	87.90	18.90	3365.00
2001	569.00	1519.00	1200.00	1383.00	3.79	0.04	1875	8.20	177.50	19.30	34.50	1.80	26.80		3.00	239.00	11.40	2915.00
2002	574.00	1427.00	1100.00	922.00	6.70	0.02	1375	58.60	338.80	37.40	19.30	27.00	102.00	693.00	677.00	278.20	17.00	1790.00
2003	411.00	1755.00	1443.00	1557.91	2.50	0.02	3059	126.10	19.00	11.00	9.70	9.10	31.70	266.00	873.00	260.20	9.60	1842.00
2004	320.00	1562.00	814.00	563.84	1.60	0.03	375	26.40	42.00	1.50	248.30	2.00	29.00	125.00	320.00	246.10	8.70	423.00
2005	242.00	1331.00	1174.00	297.66	1.60	0.03	1348	30.90	24.80	2.50	3.40	0.10	20.50	105.00	612.00	87.70	7.40	758.00
2006	208.00	320.00	2736.00	557.00	1.50		402	35.10	25.90	2.50	94.40	0.10	38.10	0.04	467.00	122.50	6.80	559.00
2007	292.00	1140.00	905.00	610.67	2.70		flood	18.40	60.80	112.60	76.00	4.45	77.00		757.00	62.00	7.00	6619.00
2008	129.00		75.00	445.00	0.70		1153	31.00	9.70	3.80	4.30	4.05	31.70	4.00	1303.00	131.00	0.90	
2009	78.00	1333.00		411.00	0.40		5614								153.00			

*** data resides with the WG/ICES and the can be requested from ICES or a group member.**

Table 2.2 cont.: Series information.

	loc_id	loc_name	loc_comment	loc_x	loc_y	loc_tyl_code	loc_area	loc_country	rec_river	rec_location	rec_samplingtype	rec_remark	rec_order	unit
1	1	IYFS scientific estimate	to be updated	NA	NA	Recruit	North sea	Sweden	?	IYFS/IBTS (old data)	scientific estimate	to be updated	1	Index
2	41	IYFS2 scientific estimate	to be updated	NA	NA	Recruit	North sea	Sweden	?	IYFS/IBTS (new data)	scientific estimate	to be updated	2	Index
3	2	Ringhals scientific survey	to be updated	12	57	Recruit	North sea	Sweden	Kattegat-Skagerrak	Ringhals	scientific estimate	to be updated	3	Kg
4	3	Viskan Sluices trapping all	to be updated	12	57	Recruit	North sea	Sweden	Viskan	Sluices	trapping all	to be updated	4	Kg
5	4	Bann Coleraine trapping partial	to be updated	-6	55	Recruit	British Isle	Northern Ireland	Bann	Coleraine	trapping partial	to be updated	5	Kg
6	5	Erne Ballyshannon trapping all	to be updated	-8	54	Recruit	British Isle	Ireland	Erne	Ballyshannon	trapping all	total trapping in kg glass eel + yellow	6	Kg
7	6	Shannon Ardnacrusha trapping all	to be updated	-8	52	Recruit	British Isle	Ireland	Shannon	Ardnacrusha	trapping all	total trapping glass eel + yellow in kg	7	Kg
8	45	River Feale	new data 2009	NA	NA	Recruit	Atlantic Ocean	Ireland	Feale	NA	trapping all	glass eel trapping (kg)	8	Kg
9	46	River Maigue	new data 2009	NA	NA	Recruit	Atlantic Ocean	Ireland	Maigue	NA	trapping all	glass eel trapping (kg)	9	Kg
10	47	River Inagh	new data 2009	NA	NA	Recruit	Atlantic Ocean	Ireland	Inagh	NA	trapping all	glass eel trapping (kg)	10	Kg
11	7	Severn EA commercial catch	to be updated	-2	51	Recruit	British Isle	UK	Severn	EA	commercial catch	to be updated	11	Kg
12	8	Severn HMRC commercial catch	to be updated	-2	51	Recruit	British Isle	UK	Severn	HMRC	commercial catch	to be updated	12	Kg
13	9	Vidaa Højer sluice commercial catch	to be updated	8	56	Recruit	North sea	Denmark	Vidaa	Højer sluice	commercial catch	to be updated	13	Kg
14	10	Ems Herbrum commercial catch	to be updated	7	53	Recruit	North sea	Germany	Ems	Herbrum	commercial catch	to be updated	14	Kg
15	11	Lauwersoog scientific estimate	to be updated	NA	NA	Recruit	North sea	Netherlands	?	Lauwersoog	scientific estimate	to be updated	15	Index
16	12	Rhine DenOever scientific estimate	to be updated	5	53	Recruit	North sea	Netherlands	Rhine	DenOever	scientific estimate	to be updated	16	Index
17	13	Rhine Ijmuiden scientific estimate	to be updated	NA	NA	Recruit	North sea	Netherlands	Rhine	Ijmuiden	scientific estimate	to be updated	17	Index
18	14	Katwijk scientific estimate	to be updated	NA	NA	Recruit	North sea	Netherlands	?	Katwijk	scientific estimate	to be updated	18	Index
19	15	Stellendam scientific estimate	to be updated	NA	NA	Recruit	North sea	Netherlands	?	Stellendam	scientific estimate	to be updated	19	Index
20	16	Ijzer Nieuwpoort scientific estimate	to be updated	2	51	Recruit	North sea	Belgium	Ijzer	Nieuwpoort	scientific estimate	to be updated	20	Kg
21	17	Vilaine Arzal trapping all		2	47	Recruit	Atlantic Ocean	France	Vilaine	Arzal	trapping all	Fishery corrected	21	Kg
22	18	Loire Estuary commercial catch		2	47	Recruit	Atlantic Ocean	France	Loire	Estuary	commercial catch		22	Kg
23	19	Sèvres Niortaise Estuary commercial CPUE	to be updated	NA	NA	Recruit	Atlantic Ocean	France	Sèvres Niortaise	Estuary	commercial CPUE	to be updated	23	cpue
24	20	Gironde Estuary (catch) commercial catch		0	45	Recruit	Atlantic Ocean	France	Gironde	Estuary (catch)	commercial catch		24	t
25	21	Gironde Estuary (CPUE) commercial CPUE		0	45	Recruit	Atlantic Ocean	France	Gironde	Estuary (CPUE)	commercial CPUE		25	cpue
26	42	Gironde scientific estimate	last update 2007	NA	NA	Recruit	Atlantic Ocean	France	Gironde	Scientific Survey	scientific estimate	last update 2007	26	Index
27	22	Adour Estuary (catch) commercial catch	only marine fishermen since 2000	1	43	Recruit	Atlantic Ocean	France	Adour	Estuary (catch)	commercial catch	only marine fishermen since 2000	27	t
28	23	Adour Estuary (CPUE) commercial CPUE		1	43	Recruit	Atlantic Ocean	France	Adour	Estuary (CPUE)	commercial CPUE		28	cpue
29	24	Nalon Estuary commercial catch	beware data year n-1 (2008-2009) labeled 2008 in the report as the main season is 2008 in Spain	6	43	Recruit	Atlantic Ocean	Spain	Nalon	Estuary	commercial catch	This series comprises the San Juan de La Arena Fish Market sellings but those are in fact only a part of the Nalon river true landings (Nalon Landings series available from 1995 is somewhat higher)	29	Kg
30	25	Albufera de Valencia commercial catch	beware data year n-1 (2008-2009) labeled 2008 in the report as the main season is 2008 in Spain	0	39	Recruit	Mediterannean Sea	Spain	Albufera lagoon	Albufera de Valencia	commercial catch	to be updated	30	Kg
31	26	Minho spanish part commercial catch	beware data year n-1 (2008-2009) labeled 2008 in the report as the main season is 2008 in Spain	9	42	Recruit	Atlantic Ocean	Spain	Minho	spanish part	commercial catch	to be updated	31	Kg
32	27	Minho portugese part commercial catch	to be updated	9	42	Recruit	Atlantic Ocean	Portugal	Minho	portugese part	commercial catch	to be updated	32	Kg
33	43	Ebro delta lagoons	beware data year n-1 (2008-2009) labeled 2008 in the report as the main season is 2008 in Spain New data 2009	0	40	Recruit	Mediterannean Sea	Spain	Ebro delta lagoons\"□river delta from the Ebro"	commercial catch	new data in 2009		33	Kg
34	44	Albufera de Valencia commercial CPUE	beware data year n-1 (2008-2009) labeled 2008 in the report as the main season is 2008 in Spain/ new data 2009	0	39	Recruit	Mediterannean Sea	Spain	Albufera lagoon	NA	commercial CPUE	new data in 2009	34	cpue
35	28	Tiber Fiumara Grande commercial catch	to be updated	12	41	Recruit	Mediterannean Sea	Italy	Tiber	Fiumara Grande	commercial catch	to be updated	35	t
36	29	Imsa Near Sandnes trapping all	to be updated	6	59	Recruit	North sea	Norway	Imsa	Near Sandnes	trapping all	to be updated	100	Number
37	30	Dalälven trapping all	370 mm average size	NA	NA	Recruit	Baltic	Sweden	Dalälven	?	trapping all	370 mm average size	101	Kg
38	31	Motala Ström trapping all	to be updated	NA	NA	Recruit	Baltic	Sweden	Motala Ström	?	trapping all	to be updated	102	Kg
39	32	Mörrumsån trapping all	to be updated	NA	NA	Recruit	Baltic	Sweden	Mörrumsån	?	trapping all	to be updated	103	Kg
40	33	Kävlingeån trapping all	320 mm average size	NA	NA	Recruit	Baltic	Sweden	Kävlingeån	?	trapping all	320 mm average size	104	Kg
41	34	Rönne Å trapping all	to be updated	NA	NA	Recruit	North sea	Sweden	Rönne Å	?	trapping all	to be updated	105	Kg
42	35	Lagan trapping all	to be updated	NA	NA	Recruit	North sea	Sweden	Lagan	?	trapping all	to be updated	106	Kg
43	36	Göta Älv trapping all	to be updated	NA	NA	Recruit	North sea	Sweden	Göta Älv	?	trapping all	to be updated	107	Kg
44	37	Shannon Parteen trapping partial	to be updated	NA	NA	Recruit	British Isle	Ireland	Shannon	Parteen	trapping partial	Juvenile yellow eel catch (kg)	108	Kg
45	38	Guden Å Tange trapping all	to be updated	NA	NA	Recruit	North sea	Denmark	Guden Å	Tange	trapping all	to be updated	109	Kg
46	39	Harte trapping all	to be updated	NA	NA	Recruit	North sea	Denmark	Harte	?	trapping all	to be updated	110	Kg
47	40	Meuse Lixhe dam trapping partial	to be updated	NA	NA	Recruit	North sea	Belgium	Meuse	Lixhe dam	trapping partial	to be updated	111	Kg

*** data resides with the WG/ICES and the can be requested from ICES or a group member.**

Table 2.3: Total landings (all life stages) from 2009 Country Reports, except note Finland, Latvia, Lithuania, Netherlands, Portugal, Spain, France and UK (see Table notes at bottom of table).

	Belgium	Denmark	Estonia	Finland □	France Δ	Germany	Ireland	Italy	Latvia □	Lithuania □	Netherlands ●	Norway	Poland	Portugal #	Spain ●	Sweden	UK √
1945		4169									2668	102				1664	
1946		4269							1		3492	167				1512	
1947		4784							10	8	4502	268				1910	
1948		4386							10	14	4799	293				1862	
1949		4492							11	21	3873	214				1899	
1950		4500							14	29	4152	282			90	2188	
1951		4400							13	32	3661	312			102	1929	
1952		3900							14	39	3978	178			80	1598	
1953		4300							30	80	3157	371			98	2378	
1954		3800							24	147	2085	327	609		103	2106	
1955		4800							47	163	1651	451	732		106	2651	
1956		3700							26	131	1817	293	656		80	1533	
1957		3600							25	168	2509	430	616		115	2225	
1958		3300							27	149	2674	437	635		100	1751	
1959		4000				84			30	155	3413	409	566		98	2789	
1960		4723				51			44	165	2999	430	733		95	1646	
1961		3875				48			50	139	2452	449	640		91	2066	
1962		3907				67			46	155	1443	356	663		95	1908	
1963		3928				55			64	260	1618	503	762		92	2071	
1964		3282				56			43	225	2068	440	884		76	2288	
1965		3197				56			41	125	2268	523	682		79	1802	566
1966		3690				68			43	238	2339	510	804		80	1969	618
1967		3436				92			46	153	2524	491	906		66	1617	570
1968		4218				103			34	165	2209	569	943		57	1808	587
1969		3624				302		2469	43	134	2389	522	935		0	1675	607
1970		3309				238		2300	29	118	1111	422	847		43	1309	754
1971		3195				255		2113	29	124	853	415	722		44	1391	844
1972		3229				239		1997	25	126	857	422	696		44	1204	634
1973		3455				257		588 *	27	120	823	409	636		33	1212	725
1974		2814				224		2122	20	86	840	368	796		25	1034	767
1975		3225				226		2886	19	114	1000	407	793		17	1399	764
1976		2876		28		205		2596	24	88	1172	386	803		14	935	627
1977		2323		63		214		2390	16	68	783	352	903		0	989	692
1978		2335		77		163		2172	18	70	719	347	946		0	1076	825
1979		1826		77		158		2354	21	57	530	374	912		0	956	1206
1980		2141		79		140		2198	9	45	664	387	1221		11	1112	1110
1981		2087		39		131		2270	10	27	722	369	1018		19	887	1139
1982		2378		38		166		2025	12	28	842	385	1033		16	1161	1189
1983		2003		38		155		2013	9	23	937	324	822		14	1173	1136
1984		1745		28		114		2050	12	27	691	310	831		11	1073	1257
1985		1519		28		477		2135	18	29	679	352	1010		14	1140	1035
1986		1552		28	2462	405		2134	19	32	721	272	982		12	943	926
1987		1189		19	2720	359		2265	25	20	538	282	872		15	897	1006
1988		1759			2816	364		2027	15	23	425	513	923		10	1162	1110
1989		1582			2266	379		1243	13	21	526	313	752	14	0	952	1172
1990		1568			2170	374		1088	13	19	472	336	697	13	4	942	1014
1991		1366			1925	335		1097	14	16	573	323	580	23	0	1084	1058
1992		1342			1585	322		1084	17	12	548	372	584	30	5	1180	915
1993		1023	59		1736	250		782	19	10	293	340	495	34	5	1210	857
1994		1140	47		1694	246		771	19	12	330	472	531	27	4	1553	1077
1995		840	45		1832	242		1047	38	9	354	454	507	24	4	1205	1312
1996		718	55		1562	220		953	24	9	300	353	499	26	6	1134	1246
1997		758	59		1537	263		727	25	11	285	467	384	25	23	1382	1190
1998		557	44		1345	28		666	30	17	323	331	397	23	43	645	943
1999		687	65		1253	38		634	26	18	332	447	406	23	45	734	963
2000		600	67		1200	36		588	17	11	363	281	305	22	90	561	702
2001		671	65		1103	141	98	520	15	12	371	304	296	15	106	543	742
2002		582	50			130	123	415	19	13	353	311	236	27	80	633	650
2003		625	49			125	111	446	11	12	279	240	204	11	70	565	574
2004		531	39			117	136	379	11	16	245	237	148	9	71	551	634
2005		520	36			108	101	75 *	11	22	234	249	284	7	74	628	545
2006		581	33			87	133	56 *	8		230	293	257	10	39	670	408
2007		526	31			317	114		10		130	194	244	11		568	427
2008		457	30			398	125				122	211	227	7		495	

□ From 2008 CR, Country not present in 2009

Δ Partial, discontinued

● Partial, for area (Neth) or life stage (Spain)

√ From 2008 CR, data source unknown

 # Coastal yellow eel landings only (Portugal)

*** Only fresh water**

Table 2.4: Total landings (all life stages), only countries present in the WG, source FAO FishStat 2009/

	Belgium	Denmark	Estonia	Finland	France	Germany	Ireland	Italy	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Spain	Sweden	United Kingdom
1950	.	4500	0	0	500	400	100	895	0	0	4200	300	700	<0.5	100	2200	100
1951	.	4400	0	0	500	400	100	849	0	0	3700	300	700	<0.5	100	1900	100
1952	.	3900	0	0	700	400	100	873	0	0	4000	200	900	<0.5	200	1600	100
1953	.	4300	0	0	600	500	100	846	0	0	3100	400	900	<0.5	200	2400	200
1954	.	3800	0	0	500	300	100	830	0	0	2100	300	800	<0.5	200	2100	400
1955	.	4800	0	0	500	500	100	814	0	0	1700	500	1000	<0.5	700	2600	800
1956	.	3700	0	0	500	400	100	1796	0	0	1800	300	900	<0.5	800	1500	600
1957	.	3600	0	0	500	400	100	1776	0	0	2500	400	800	<0.5	500	2200	600
1958	.	3300	0	0	600	400	100	1754	0	0	2800	400	1200	<0.5	500	1800	500
1959	.	4000	0	0	900	500	100	2614	0	0	3400	400	700	<0.5	600	2800	700
1960	.	4700	0	0	1300	400	100	2276	0	0	3000	400	1000	<0.5	400	1600	800
1961	.	3900	0	0	1300	500	100	2134	0	0	2500	500	900	<0.5	400	2100	800
1962	.	3900	0	0	1300	400	100	2589	0	0	1600	400	1000	<0.5	800	1900	700
1963	.	4000	0	0	1400	2100	100	2939	0	0	1900	500	1000	<0.5	1300	1900	700
1964	.	3300	0	0	1400	1900	100	2884	0	0	2500	400	1100	<0.5	1800	2368	600
1965	.	3200	0	0	1700	1500	200	2524	0	0	2600	500	900	<0.5	1400	1868	800
1966	.	3700	0	0	1300	1700	100	2357	0	0	2800	500	1000	<0.5	1400	2070	1000
1967	.	3500	0	0	2000	1900	100	2286	0	0	3100	500	1100	<0.5	1500	1667	600
1968	.	4300	0	0	2700	1800	100	2306	0	0	2700	600	1100	<0.5	1400	1872	600
1969	.	3700	0	0	1900	1600	100	2418	0	0	2800	500	1100	<0.5	1500	1773	600
1970	-	3400	0	0	3091	1600	200	3292	0	0	1500	400	1000	-	1100	1270	800
1971	-	3200	0	0	4521	1300	200	3408	0	0	1200	400	900	-	1100	1469	800
1972	-	3300	0	0	2600	1300	200	2893	0	0	1100	400	900	-	1500	1274	700
1973	-	3554	0	0	3937	1282	91	2910	0	0	1105	409	825	47	700	1213	800
1974	-	2870	0	0	2493	1285	67	2697	0	0	1029	368	891	42	1300	1030	817
1975	-	3293	0	0	1590	1398	79	2973	0	0	1213	407	917	44	570	1492	833
1976	-	2926	0	27	2959	1322	150	2677	0	0	1353	386	674	38	675	1023	694
1977	-	2381	0	63	1538	1317	108	2462	0	0	961	352	996	52	666	1084	742
1978	-	2379	0	77	2455	1162	76	2237	0	0	891	347	941	44	655	1162	877
1979	-	1860	0	77	3144	1164	110	2422	0	0	729	374	1007	25	460	1038	879
1980	-	2254	0	64	1921	1051	75	2264	0	0	877	387	910	32	344	1205	1053
1981	-	2229	0	31	1425	1033	94	2340	0	0	898	369	752	33	250	976	858
1982	-	2538	0	30	1469	1027	144	2087	0	0	1153	385	895	14	269	1250	1032
1983	-	2120	0	30	1856	1029	117	2076	0	0	1288	324	1103	11	188	1302	1113
1984	-	1855	0	24	2306	911	88	2361	0	0	723	310	1698	20	170	1161	957
1985	48	1601	0	23	2228	866	87	1907	0	0	688	352	1337	16	215	1211	781
1986	48	1643	0	25	2687	887	87	1928	0	0	685	272	1134	42	226	922	997
1987	48	1273	0	1	1978	731	230	2076	0	0	359	282	962	<0.5	297	703	939
1988	48	1784	11	1	2109	746	215	2165	4	94	433	513	1087	<0.5	224	965	715
1989	48	1696	32	1	1672	678	400	1301	8	81	332	313	1109	<0.5	119	952	1075
1990	30	1674	74	0	1674	978	256	1199	0	120	209	336	913	28	104	941	1039
1991	30	1464	3	0	1450	1010	245	1106	0	16	160	323	1097	44	85	1085	822
1992	30	1448	9	0	1164	1026	234	1662	19	12	89	372	1095	52	97	1180	782
1993	30	1081	59	0	864	1027	260	1307	18	10	419	340	1116	-	77	1144	752
1994	30	1200	54	0	607	585	300	986	39	12	358	472	1090	-	80	1298	873
1995	30	904	38	0	320	584	400	886	28	10	433	454	627	-	68	1100	808
1996	30	735	54	22	403	696	400	883	26	12	336	353	639	-	68	1042	894
1997	30	796	56	22	1782	746	400	1010	29	11	316	497	489	-	72	1073	812
1998	30	600	44	0	449	717	400	682	27	17	344	363	454	-	23	645	741
1999	30	711	60	0	289	746	250	645	17	18	372	475	474	30	39	736	697
2000	30	620	67	0	399	686	250	549	15	11	351	281	429	29	70	561	796
2001	30	658	67	0	415	638	110	446	19	12	374	304	425	37	62	580	595
2002	30	569	50	0	402	636	104	402	11	13	373	311	361	36	93	634	571
2003	30	620	49	0	412	251	81	458	11	13	366	240	321	13	40	565	588
2004	30	534	40	0	321	243	119	387	12	16	331	237	270	11	57	568	504
2005	30	531	29	0	186	285	87	115	17	22	317	249	220	9	55	668	493
2006	30	582	33	0	219	303	120	64	8	16	316	296	184	12	86	730	405
2007	30	526	31	0	226	294	94	109	10	15	258	194	181	12	50	698	486

*** data resides with the WG/ICES and the can be requested from ICES or a group member.**

Table 2.5. Status of recreational and non-commercial eel fishing in 2008-'Prohibited' (by law), 'Active' (permitted under regional angling licence), 'n/a' (not applicable due to non-occurrence in the region).

	Glass eel	Yellow eel	Silver eel
Norway	Prohibited	Prohibited	Prohibited
Sweden	Prohibited	Prohibited	Prohibited
Estonia	n/a	Active	Active
Poland	n/a	Active	Active
Germany	Prohibited	Active	Active
Denmark	Prohibited	Active	Active
Netherlands	Prohibited	Active	Active
Belgium	Prohibited	Active1/prohib2	Active1/prohib2
France	Active	Active	Active
Spain*	Active	Active	Active
Portugal	Prohibited**	Active	n/a
UK	Prohibited	Active	Active
Ireland	Prohibited	Active	Active
Italy	Prohibited	Active	Active

1 = Flanders

2 = Walloon Region

Table 2.6: Stocking of glass eel. Numbers of glass eels (in millions) stocked in Germany (DE), Lithuania (LT), the Netherlands (NL), Sweden (SE), Poland (PL), Northern Ireland (N.Irland), Belgium (BE), Estonia (EE), Finland (FI) Latvia (LV) and Spain (ES).

	DE	NL	SE	PL	N.Irl.	BE	EE	FI	LT	LV	ES
1927										0.3	
1928									0.1		
1929									0.2		
1930											
1931									0.2	0.4	
1932									0.2		
1933									0.2	0.3	
1934									0.3		
1935									0.6	0.2	
1936									0.3		
1937									0.3	0.3	
1938									0.4		
1939									0.1	0.2	
1940											
1941											
1942											
1943											
1944											
1945											
1946		7.3									
1947		7.6									
1948		1.9									
1949		10.5									
1950		5.1									
1951		10.2									
1952		16.9		17.6							
1953	2.2	21.9		25.5							
1954	0	10.5		26.6							
1955	10.2	16.5		30.8							
1956	4.8	23.1		21			0.2		0.3		
1957	1.1	19		24.7							
1958	5.7	16.9		35							
1959	10.7	20.1		52.5							
1960	13.7	21.1		64.4			0.6		2.3	3.2	
1961	7.6	21		65.1							
1962	14.1	19.8		61.6			0.9		2	1.9	
1963	20.4	23.2		41.7					1	1.5	
1964	11.7	20		39.2			0.2		2.4	0.9	
1965	27.8	22.5		39.8			0.7		2.1	0.4	
1966	21.9	8.9		69				1.1	0.7		
1967	22.8	6.9		74.2				3.9	0.5	1	
1968	25.2	17		16.6			1.4	2.8	3	3.7	
1969	19.2	2.7		2					0		
1970	27.5	19		23.5			1		2.8	1.8	
1971	24.3	17		17.4					1.6		
1972	31.5	16.1		21.5			0.1		0.3	1.6	
1973	19.1	13.6		61.9					1.4		
1974	23.7	24.4		71			1.8		1.8		
1975	18.6	14.4		70					2.2		
1976	31.5	18		68			2.6		1	0.6	
1977	38.4	25.8		77			2.1		1.4	0.5	
1978	39	27.7		73			2.7	3.7	2.7		
1979	39	30.6		74.3					0.75		
1980	39.7	24.8		52.9			1.3		1.8		
1981	26.1	22.3		60.5			2.7		3	1.8	
1982	30.6	17.2		64			3		4.6		
1983	25.2	14.1		25.1			2.5		3.7	1.5	
1984	31.5	16.6		49.2	4		1.8				
1985	6	11.8		36.3	10.92		2.4		1.6	1.5	
1986	23.8	10.5		54.4	17.81		2.5		2.6		
1987	26.3	7.9		56.8	13.75		2.5			0.3	
1988	26.6	8.4		15.9	6.32					2.2	
1989	14.3	6.8		5.9							
1990	16.7	6.1	0.7	8.6				0.1			
1991	3.2	1.9	0.3	1.7			2	0.1			
1992	6.5	3.5	0.3	13.8	2.36		2.5	0.1			
1993	8.6	3.8	0.6	10.6		0.8		0.1			
1994	9.5	6.2	1.7	12.2	2.32	0.5	1.9	0.1	0.1		
1995	6.6	4.8	1.5	23.7	2.06	0.5		0.2	1	0.6	
1996	0.8	1.8	2.4	2.8	0.1	0.5	1.4	0.1	0.4		0.07
1997	1	2.3	2.5	5.1	0.21	0.4	0.9	0.1			0.07
1998	0.4	2.5	2.1	2.5	0.05		0.5	0.1	0.1		0.11
1999	0.6	2.9	2.3	4	3.6	0.8	2.3	0.06		0.3	0.16
2000	0.3	2.8	1.37	3.1	0.45		1.1	0.06			0.05
2001	0.3	0.9	0.84	0.7		0.2		0.05			0.01
2002	0.3	1.6	1.69		3.02			0.06		0.23	0.04
2003	0.1	1.6	0.83	0.5	4.1	0.3			0.4		0.06
2004	0.2	0.3	1.29	2.3	1.28			0.06			0.07
2005	0.6	0.1	1.01		2.16			0.06		0.12	
2006		0.59	1.14		0.99	0.3		0.05		0.01	
2007	1.6	0.22	1.01		3	0		0.1		0.02	0.03
2008			1.39		1.28	0.3		0.1			
2009		0.2	0.77		0.65	0.4					

Table 2.7: Stocking of young yellow eel. Numbers of young yellow eels (in millions) stocked in Germany (DE), Lithuania (LT). the Netherlands (NL), Sweden (S), Denmark (DK), Belgium (BE), Estonia (EE), Finland (FI), Latvia (LV) and Spain (ES).

	DE	NL	SE	DK	BE	EE	FI	LT	LV	PL	ES
1927											
1928											
1929											
1930											
1931											
1932											
1933											
1934											
1935											
1936											
1937											
1938											
1939											
1940											
1941											
1942											
1943											
1944											
1945											
1946											
1947		1.6									
1948		2									
1949		1.4									
1950	0.9	1.6									
1951	0.9	1.3									
1952	0.6	1.2									
1953	1.5	0.8									
1954	1.1	0.7									
1955	1.2	0.9									
1956	1.3	0.7									
1957	1.3	0.8									
1958	1.9	0.8									
1959	1.9	0.7									
1960	0.8	0.4									
1961	1.8	0.6					0.1		1		
1962	0.8	0.4					0.1		0.7		
1963	0.7	0.1							0.4		
1964	0.8	0.3					0.1		0.4		
1965	1	0.5					0.1		0.3		
1966	1.3	1.1					0.1				
1967	0.9	1.2							0.8		
1968	1.4	1									
1969	1.4										
1970	0.7	0.2							0.4		
1971	0.6	0.3									
1972	1.9	0.4									
1973	2.7	0.5								0.2	
1974	2.4	0.5									
1975	2.9	0.5									
1976	2.4	0.5							0.3		
1977	2.7	0.6								0.1	
1978	3.3	0.8									
1979	1.5	0.8					0.1				
1980	1	1									
1981	2.7	0.7									
1982	2.3	0.7							0.3	0.1	
1983	2.3	0.7							0.4	2.3	
1984	1.7	0.7								0.3	
1985	1.1	0.8								0.5	
1986	0.4	0.7								0.2	
1987	0.3	0.4		1.58							
1988	0.2	0.3		0.75		0.2			0.8	0.1	
1989	0.2	0.1		0.42						0.7	0.06
1990	0.4		0.8	3.47						1	0.03
1991	0.5		0.9	3.06						0.1	0.06
1992	0.4		1.1	3.86						0.1	0.06
1993	0.7	0.2	1	3.96	0.2						0.17
1994	0.8		1	7.4	0.1			0.1		0.1	0.12
1995	0.8		0.9	8.44	0.1	0.2					0.22
1996	1.1	0.2	1.1	4.6	0.1					0.5	0.1
1997	2.2	0.4	1.1	2.53	0.1					1.1	0.14
1998	1.7	0.6	0.9	2.98	0.1			0.1		0.6	0.09
1999	2.4	1.2	1	4.12	0.04			0.1		0.5	0.04
2000	3.3	1	0.67	3.83						0.8	0.05
2001	2.4	0.1	0.44	1.7		0.44				0.6	0.06
2002	2.4	0.1	0.26	2.43	0.01	0.36			0.2	0.6	0.04
2003	2.6	0.1	0.27	2.24	0.01	0.54				0.5	0.06
2004	2.2	0.1	0.18	0.75	0.01	0.44		0.1		0.5	0.06
2005	2.1		0.07	0.3	0.01	0.37				0.7	0.12
2006	5.5			1.6		0.38				1.1	
2007	9.1			0.83		0.33				0.9	0.02
2008		0.23		0.75		0.19				1	0.04
2009		0.2		0.81		0.42				1	0.02

Table 2.8: Data on surface area, production and escapement per country and Eel Management Unit. Data from the Country Reports.

Country	EMU/RBD	WETTED AREA(`000 ha) inland	transitional	coastal	Production (kg/ha)	Potential Escapement	Escapement
Poland	Oder	179	45.7	646.5	n.a	308 000 *	216 000 *
	Vistula	150	32.8	344.1		371 000 *	208 000 *
Sweden	All areas	3276.3	1784.3		0.067	2 870 000 * /2 600	1 100 000* /1 210 **
Denmark	All areas	60	n.a	n.a	n.a	300 000 * / 100** (i) 600 ** (m)	< 69** (i) 600 ** (m)
France	Rhin	7.7	0	0			
	Meuse	3.7	0	0		26 000 *	
	Artois Picardie	24.5	15.1	n.a		234 000 *	
	Seine Normandie	88	26	194		1 341 000 *	
	Bretagne	16.4	21.5	n.a		1 259 000 *	
	Loire	94.4	29.6	3250	n.a	1 231 000. *	n.a
	Garonne Dordogne	54.3	60.1	60		6 706 000 *	
	Adour	27.2	0.4	n.a		1 352 000 *	
	Rhône-Méditerranée	n.a	n.a	n.a		2 149 000. *	
	Corse	n.a	n.a	n.a		544 000 *	
England &Wales	Northumbria	6.7	2.6	70.4			36.3 ** (i)
	Humber	14.4	33.7	32.9			132.6 ** (i)
	Anglian	15.9	33.2	228.6			12.6 ** (i)
	Thames	7.4	33.5	14.5			309 ** (i)
	South East	2.4	5.5	211.2			81.9 ** (i)
	South West	7.5	22.9	304.2			176.3 ** (i)
	Severn	13	54.7	0	n.a	n.a	133.4 ** (i)
	West Wales	8.7	13.5	433.1			93.2 ** (i)
	Dee	2.2	10.9	0			0.068 ** (i)
	North West	11.1	27.9	150.9			200.2 ** (i)
	Solway-Tweed	23.4	39	191.3			118.1 ** (i)
Scotland	Scotland	186.7	n.a	n.a	84.9 ** (i)	84.9 ** (i)	84.9 ** (i)
N.Ireland	North Eastern	0.5	7.7	8.2	5	n.a	n.a
	Neagh Bann	40	0	40	9.6	400 – 600 **	360 ** (i)
	North Western	33	1.2	34.1	5.2	50 – 60 **	n.a
Germany	Eider	7.9	1.7	459.2	0.2 – 3.9		127 **
	Elbe	154.8	46,3	n.a	2.1		425 ** (i)
	Ems	7.8	36,1	n.a	6.5		284 ** (i)
	Maas	0.89	n.a	n.a	0.1		0 ** (i)
	Oder	51.9	28.5	n.a	1.2	n.a	100 ** (i)
	Rhein	58.9	n.a	n.a	2.9		173 ** (i)
	Schlei/Trave	23	0	310.8	0.9 – 2.9		358 **
	Warnow/Peene	34.8	0	310	0.6 – 2.6		822 **
	Weser	20.1	34.6	n.a	4.8		261 ** (i)
Portugal	Minho&Lima Cavado,Ave&Leca Douro Vouga,Mondego,Lis Tejo Sado&Mira Guadiana Algavere streams	n.a	n.a	n.a	n.a	n.a	n.a
Ireland	Eastern	7	2.3	35.9	1.3 – 2.7 for inland area	14 **	7 **
	South-Eastern	4.2	9	102.4		10 **	9 **
	Shannon	45.3	25	122		94 **	18 **
	South-Western	10.7	16.6	357.6		17 **	17 **
	Western	49.9	13.3	457.4		97 **	51 **
	North-Western	36.7	13.1	223		104 **	38 **
Netherlands	All areas	321.1	358.8		0.32 – 7.19	n.a	n.a
Belgium	Scheldt Meuse	n.a	n.a	n.a	n.a	n.a	n.a
Spain	Galicia Asturias Cantabria Basque Country Navarra Cataluña Ebro Valencia Castilla La Mancha Murcia Isla Baleares Andalucía	n.a	n.a	n.a	n.a	n.a	n.a
Estonia	East-Estonian	200	n.a	n.a	n.a	n.a	n.a
	West-Estonian			1500			

Table 2.9: Main actions proposed in the national EMP`s (data from country reports).

Country	Stocking	Anthropogenic mortality		
	Amount of glass eel/year	Commercial fishery	Recreational fishery	Hydropower / pumping stations
POLAND	14 000 000 individuals	-25%		- ~30 %
SWEDEN	2 500 000 individuals	-80%		-50%
DENMARK	3-4 tons (inland) 33 tons (marine)	-50%	YES	YES
FRANCE	3.82 tons Some data n.a	-30%	-30%	n.a
ENGLAND & Wales	Not proposed	YES	YES	YES
SCOTLAND	Not proposed	Licenced control	Licenced control	n.a
N.IRELAND	12 000 000 individuals	n.a	n.a	n.a
GERMANY	increase present stocking	YES	YES	YES
PORTUGAL	n.a	YES	-100%	YES
IRELAND	n.a	- ~40 %	NO	YES
NETHERLANDS	n.a	YES	YES	YES
BELGIUM	n.a	YES	n.a	YES
SPAIN	35 % of their own catches	NO	NO	YES
ESTONIA	n.a	YES	n.a	n.a
ITALY	n.a	n.a	n.a	n.a
NORWAY	0	-100%	-100%	n.a

Table 2.10: Process of evaluation of quality for five Country Reports.

PROCESS OF EVALUATION OF QUALITY FOR 5 COUNTRY REPORTS STAGE			Glass eel		
		Scientific	Catch	Effort	Cpue
Necessary INFORMATION	**CONDITIONS required**		forbidden in 3 of 5 countries restocking capture		
Scale 1					
General level: global, country					
0 Does the data, results exists all?		y,y	y,y	y,y	y,y
01 What spatial level available? (C, B)	survey site, catch	site 2	District 2	Basin, River	Basin, River
02 What time period ? (ponctual, series)	time unit	annual 2	annual 2	annual 2	annual 2
	continuous or broken	broken 2	broken, not known	broken, not known	broken, not known
Scale 2					
Detailed level: local, Basin, tributary, reach					
1Origin: Method of collection	detailed protocol of collection available?	n, y	y,y	n y	n y
11 type of Monitoring system		y,y	y,y	n y	n y
12 Who is Responsible?		y,y	y,y	y,y	y,y
2 Location (spatial coverage, detail C, B)	clear and appropriate limits	y,y	y,y	y,y	y,y
3 Period consistancy, year, season	clear and appropriate limits	n, y	y,y	y,y	y,y
4 stage	specified or aggregated	y, y	y,y	y,y	y,y
5 Representativeness of the data					
50 Fishermen catégory	is there a list of categories?	n/a	y, n/a	y, n/a	y, n/a
51 Sample or whole population?	is the protocol of calculation described	y, y			
52 Whole population	or is the whole population included		y, n/a	y, n/a	y, n/a
53 Unknown					
54 All fisher categories described?					
55 Poachers ? Estimation	is there any measure of this, and use?	n/a 2	n, n/a	n, n/a	n, n/a

PROCESS OF EVALUATION OF QUALITY FOR 5 COUNTRY REPORTS STAGE			Glass eel		
		Scientific	Catch	Effort	Cpue
6-7 Precision of the data					
61 fleet, metier	is there clear definition and content	n, y	n, n/a	y, n/a	y, n/a
62 Unit	what are these?	counts 2	kg 2	day2, hour	kg day2 or hour
7 Serie, dimension	definition of limits	y	n 2	n 2	n 2
71 Time coverage		y	y2	n 2	n 2
72 Spatial coverage		y	y, 2	n 2	n 2
73 Changes, What, Why, dates	different protocols,	y	y2	y2	y2
	evolution of fishing power		not described, described	not des., described	not des., described
8 Accuracy of the data					
81 of basic data	mode of verification, correction,	n	no / n/a	no / n/a	no / n/a
82 of results = aggregated data	protocol of calculation	n/a	no / n/a	no / n/a	no / n/a
9 Overall Quality = Reliability (level), value					

Annex 9: Country Reports 2009: Eel stock and fisheries reported by country

In preparation to the Working Group, participants of each country have prepared a Country Report, in which the most recent information on eel stock and fishery are presented. These Country Reports aim at presenting the best information, which does not necessarily coincide with the official status. This Annex reproduces the Country Reports in full detail.

Participants from the following countries provided an (updated) report to the 2009 meeting of the Working Group:

- Norway
- Sweden
- Finland
- Estonia
- Poland
- Germany
- Denmark
- The Netherlands
- Belgium
- Ireland
- The United Kingdom of Great Britain and Northern Ireland
- France
- Spain
- Portugal
- Italy
- Canada

The Country Reports are available in PDF at: http://www.ices.dk/reports/ACOM/2009/WGEEL/Country_Reports_2009.pdf